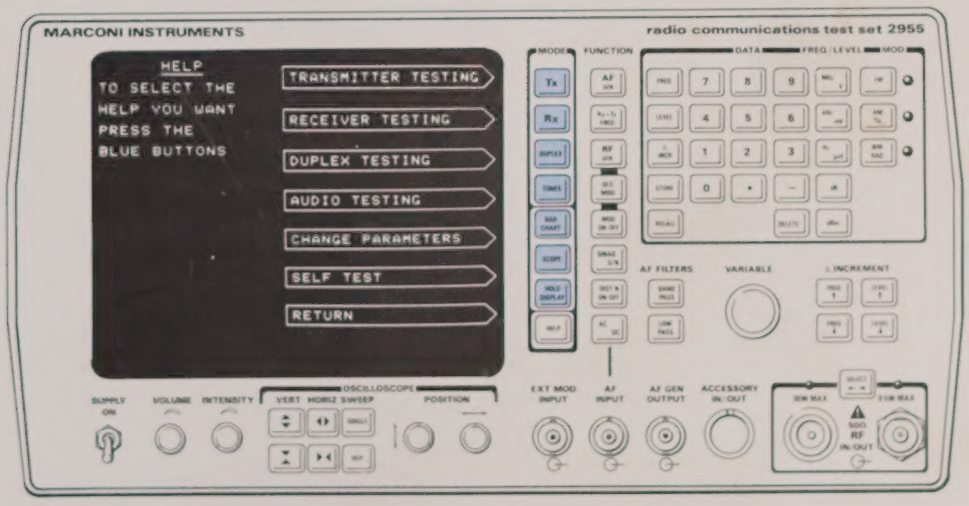
Marconi
Instruments

2955

RADIO COMMUNICATIONS TEST SET



Operating Manual

MP MASTER
MA23578

Operating Manual
H 52955-900A Vol. 1
2nd Edition

RADIO COMMUNICATIONS TEST SET 2955

Part No. 52955-900A

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Note...

Each page bears the date of its original issue or, if it has been amended, the date and status number of the amendment. Any changes subsequent to the latest amendment status are included on Manual Change sheets coded C1, C2 etc.

OPERATING PRECAUTIONS

Hazard warning symbols

The following symbols appear on the equipment.

Symbol	Type of hazard	Refer to page no.
⚠	Static sensitive device	iv
⚠	Input overload	3-7
⚠	Dangerous voltages present	iii
⚠	Supply voltage	iii

Electrical safety precautions

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

Note also that the 12 kV e.h.t. circuit for the cathode ray tube retains its charge for a considerable time after switch off. Therefore before any handling is carried out in the vicinity of the cathode ray tube or e.h.t. unit it is essential that the supply is disconnected from the instrument and the final anode lead is shorted to the chassis several times immediately after unplugging. The residual charge on the c.r.t. itself must also be removed by shorting the anode connection to earth.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous. Before fitting a non-soldered plug to the mains lead, cut off the tinned ends of the mains lead. Otherwise cold flowing of the solder could cause intermittent connections.

Fuses

Note that there is a supply fuse in both the live and neutral wires of the supply lead. If only one of these fuses should rupture, certain parts of the equipment could remain at supply potential.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

CAUTION : Static sensitive components

Components identified with the symbol ⚠ on the circuit diagrams and/or parts lists are static sensitive devices. The presence of such devices is also indicated in the equipment by orange disks, flags or labels bearing the same symbol. Certain handling precautions must be observed to prevent these components being permanently damaged by static charges or fast surges.

(1) If a printed board containing static sensitive components (as indicated by a warning disk or flag) is removed, it must be temporarily stored in a conductive plastic bag.

(2) If a static sensitive component is to be removed or replaced the following anti-static equipment must be used.

A work bench with an earthed conductive surface.

Metallic tools earthed either permanently or by repeated discharges.

A low-voltage earthed soldering iron.

An earthed wrist strap and a conductive earthed seat cover for the operator, whose outer clothing must not be of man-made fibre.

(3) As a general precaution, avoid touching the leads of a static sensitive component. When handling a new one, leave it in its conducting mount until it is required for use.

(4) If using a freezer aerosol in fault finding, take care not to spray programmable ICs as this may affect their contents.

WARNING : Handling hazards

This equipment is formed from metal pressings and although every endeavour has been made to remove sharp points and edges care should be taken, particularly when servicing the equipment, to avoid minor cuts.

Cathode ray tube: When exposing or handling the cathode ray tube care must be taken to prevent implosion and possible scattering of glass fragments. Handling should only be carried out by experienced personnel and the use of safety mask and gloves is recommended. A defective tube should be disposed of in a safe manner by an authorized waste contractor.

WARNING : Toxic hazard

Many of the electronic components used in this equipment employ resins and other chemicals which give off toxic fumes on incineration. Appropriate precautions should therefore be taken in the disposal of these items.

CAUTION: Input overload

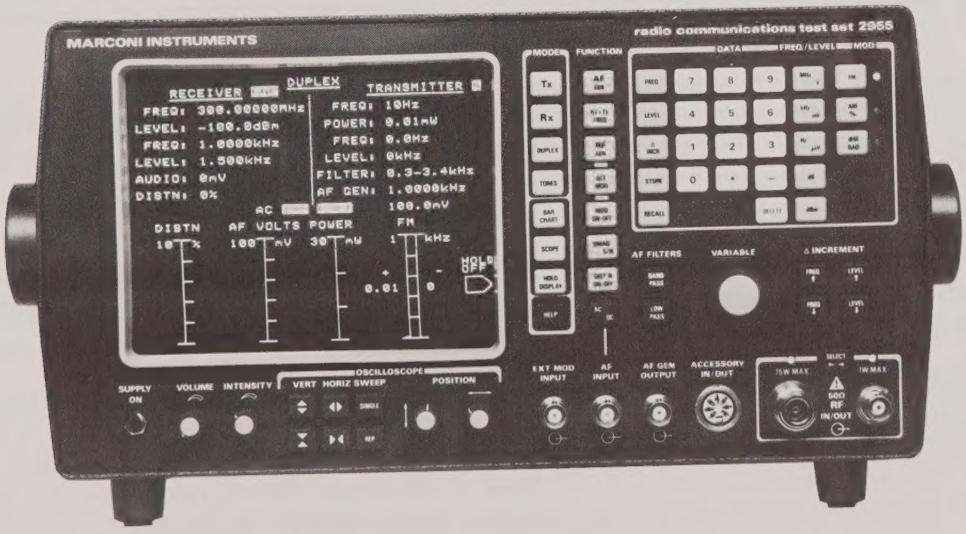
When testing transmitters, failure to respond to the displayed instruction 'REMOVE RF INPUT' which is accompanied by an audible warning could result in damage to the test set.

Chapter 1
GENERAL INFORMATION AND DATA

INTRODUCTION

Radio Communications Test Set type 2955 combines all the measurement facilities required for testing mobile radio transceivers in the range up to 1000 MHz. It is a compact self-contained unit designed for bench or mobile use and can be considered as a combination of eleven instruments as follows:-

RF counter
AF counter.
RF signal generator.
Modulation meter.
RF power meter.
AF generator.
AF and DC voltmeter.
Distortion meter.
S/N (signal to noise) and SINAD (S/N and distortion) meter.
Tones decoder and encoder.
Digital oscilloscope.



Push-button selection makes all the necessary interconnections for each measurement, eliminating the need for the many interconnections required when separate instruments are used. Function selection and data entries are made on a colour-coded keyboard with the operating sequence logically arranged from left to right. Instrument operation is greatly enhanced by the CRT display which provides prompts during data entry and guidance during operating sequences while also showing the instrument settings and measurement results. Analogue measurements are displayed by an oscilloscope with repetitive sweep, single shot and freeze facilities, as well as by five autoranging bar charts.

Counters Due to there being two frequency counters, simultaneous AF and RF frequency readings can be displayed. Ranges and resolutions are respectively 10 Hz to 20 kHz at 0.1 Hz and 1.5 to 1000 MHz at 1 or 10 Hz. Either an internal or an external frequency standard may be used.

Signal generator The signal generator can be amplitude, frequency, or phase modulated, internally or externally, the internal modulating signal being obtained from the AF generator. Amplitude modulation is variable up to 70% for carrier frequencies from 0.4 to 400 MHz. FM deviation can be set from 0 to 25 kHz, and ΦM deviation from 0 to 10 radians. Transmitter and receiver measurements can be made from a common N-type connector. The generator BNC socket is automatically protected against reverse power overloads.

Modulation meter Automatic frequency tuning and levelling of the modulation monitor provide accurate measurements of AM, FM and ΦM. Because of the independent tuning, modulation measurements are easily made on duplex systems. The modulation may be observed on an oscilloscope and its symmetry checked from the peak and trough values displayed on a dual bar chart. The demodulated output is available at a rear panel socket. Provision is made for audible monitoring using the built-in loudspeaker or by an external loudspeaker or headphones.

RF power meter The absorption RF power meter will measure up to 30 W continuously or up to 100 W for short periods, over a frequency range of 1.5 to 1000 MHz. Power levels may be observed on an autoranging bar chart in addition to the digital readout. The connection of the throughline power meter (available as an optional accessory) extends the capability of the instrument by enabling measurements of forward power, reverse power and VSWR to be made.

AF generator The AF generator provides a range of frequencies from 20 Hz to 20 kHz plus a fixed 1 kHz output used for distortion measurements and 2 tone test. Its audio output is available at a front panel socket and it also provides the internal AM, FM and ΦM for the signal generator. A combined 600 Ω balanced to unbalanced converter and 20 dB attenuator is available as an optional accessory.

AF voltmeter Operating in the range 20 Hz to 20 kHz, the true RMS audio frequency voltmeter has provisions for measuring AF or AF plus the DC component. Band-pass and low-pass filters may be selected. Level may be observed on an autoranged bar chart.

Distortion meter The AF distortion and signal to noise ratio meter and the associated SINAD meter operate at a frequency of 1 kHz supplied by the AF generator. The bar chart displays are autoranged at 10% and 30% for distortion and signal to noise, 18 dB and 50 dB for SINAD. The CCITT and C-message filters (available as optional accessories) enable psophometrically weighted measurements to be made.

Tones decoder and encoder For testing selective calling tone encoding and decoding equipment, the instrument is capable of receiving and generating four defined tone frequency standards plus a user-defined standard. Sub-audible tones can also be generated. Provision is made to receive a sequence of up to 12 and send a sequence of up to 11 out of 15 allocated tone frequencies. For transmitter testing, each received tone is compared with the standard frequency allocations held in memory and, if within limits, its tone number and % frequency error is displayed. For receiver testing, the tones may be generated in single step, tone burst or continuous cycle.

GPIB option The addition of the optional GPIB (General Purpose Interface Bus) unit greatly extends the versatility of the instrument, and allows the instrument to form part of an automatic test system. The GPIB additionally enables a display to be configured to the user's own requirements using a comprehensive character set. The GPIB also enables a 24 column ticket printer option to be used.

Calibration and test Routine calibration needs have been kept to a minimum, and calibration factors stored in a non-volatile memory may be accessed with a secure access code from the front panel keys, or via the GPIB, permitting rapid recalibration. A built-in self test facility may be called whenever required which enables faults to be identified to major module level or to groups of components.

SPECIAL FEATURES

Transmitter test

Setting:	TX key press selects test mode.
Auto-tuning:	Typically under 3 seconds to acquire and measure:- RF frequency. RF power. Modulation frequency and level. Modulation distortion.
Manual tune:	Displays positive and negative frequency offset from carrier. 3 digits and decimal point indicate most significant error.
Tones decoder:	Decodes CCIR, ZVEI, DZVEI, EEA (or EIA) and user-defined menu. Provides tone number, frequency and % error for up to 12 tones. Tone deviation and duration may be monitored using the digital storage scope in TX test mode.
RX=TX key:	Presets the RF signal generator frequency for receiver test mode to that shown in TX mode.
HOLD DISPLAY key:	Freezes screen setting and readings, facilitating high RF power measurements and hard copy printout of TX, RX, duplex or AF test screens.

Receiver test

Setting:	RX key press selects test mode. Default settings of RF level, modulation frequency and level reduce function test time.
Signal generator:	Output level accuracy >2 dB over entire frequency, temperature and attenuator ranges. Level units keyboard selectable either dBm or µV. Software menu allows user to switch between PD and EMF levels.

SINAD or S/N meter: User-settable default condition allows either SINAD or S/N readings, a dedicated key is provided to toggle the setting.

Tones encoder: Encodes CCIR, ZVEI, DZVEI, EEA (or EIA) and user-defined menu.
User may send up to 11 tones in any standard continuously, tone step or burst. A facility allows for tones to be extended.

Duplex test

Setting: Duplex key press selects test mode.

Modulation meter: Independent modulation meter and RF signal generator allows any frequency offset for duplex radio or cross-band repeater testing.

Tones encoder: Encodes CCIR, ZVEI, DZVEI, EEA (or EIA) and user-defined menu.
User may send up to 11 tones in any standard, continuously, tone step or burst. A facility allows for tones to be extended.

PERFORMANCE DATA

RF signal generator section

Output impedance: 50 Ω nominal.

VSWR: N socket; <1.2:1 to 500 MHz.
<1.35:1 to 1000 MHz.
BNC socket; <2.2:1 to 1000 MHz typical.

Frequency

Range: 0.4 MHz to 1000 MHz.

Resolution: 50 Hz up to 530 MHz.
100 Hz up to 1000 MHz.

Indication: 8 digit display.

Setting: Keyboard entry; step change variation by increment/decrement keys and rotary control.

Accuracy: As internal standard.

Output level

Range (RX mode): -140 dBm to -20 dBm (0.0224 µV to 22.4 mV PD) from N socket.
-120 dBm to 0 dBm (0.224 µV to 224 mV PD) from BNC socket.

Two-port duplex:	-120 dBm to -40 dBm (0.224 μV to 2.24 mV PD).
One-port duplex:	-140 dBm to -80 dBm (0.0224 μV to 22.4 μV PD).
Resolution:	0.1 dB.
Indication:	4 digits (dBm/μV and PD/EMF).
Setting:	10 dB and 0.1 dB steps.
Accuracy:	>2 dB for levels above -127 dBm.

Spectral purity

FM on CW:	<30 Hz up to 520 MHz, <60 Hz up to 1000 MHz. (300 Hz to 3.4 kHz weighted RMS). Typically:- 8 Hz up to 250 MHz. 15 Hz up to 500 MHz. 30 Hz up to 1000 MHz.
Harmonics:	Harmonics are in band 0.4 to 1000 MHz only. <-20 dBc up to 1.5 MHz. <-25 dBc 1.5 MHz to 250 MHz. <-20 dBc 250 MHz to 1000 MHz.
Sub-harmonics:	None up to 530 MHz, <-25 dBc up to 1000 MHz.
Spurious signals:	Carrier up to 88 MHz:- <-45 dBc below 110 MHz. <-35 dBc above 110 MHz. Carrier up to 1000 MHz:- <60 dBc.
S/N at 20 kHz offset:	<-106 dB/Hz (typical) to 500 MHz. <-100 dB/Hz (typical) to 1000 MHz.
RF leakage:	<0.5 μV PD generated in a 50 Ω load by a 2-turn 25 mm loop as near as 25 mm to the case of the instrument with the output set to less than -20 dBm and the output terminated in a 50 Ω sealed load.

Protection:

N socket; Reverse power overload indicated by visual warning (REMOVE RF INPUT) and audible alarm.
BNC socket; Trip circuit operates at approximately 1.0 W. Reverse power protection up to 50 W. Automatically resets on removal of power input. Tripping indicated by visual warning (REMOVE RF INPUT) and audible alarm.

Modulation section

Amplitude modulation

CW range:	1.5 to 400 MHz, usable to 400 kHz.
Modulation range:	0 to 70%, usable to 85%.
Frequency range:	50 Hz to 15 kHz.
Resolution:	1%.
Indication:	2 digits.
Setting:	Keyboard entry; step change variation by increment/ decrement keys and rotary control.
Accuracy:	±7% of setting ±1 digit at 1 kHz. ±10% of setting ±1 digit from 50 Hz to 5 kHz up to 60% AM. ±15% of setting ± digit from 50 Hz to 15 kHz up to 70% AM.

AM external input

Input impedance:	1 MΩ in parallel with approximately 40 pF.
CW range:	1.5 to 400 MHz.
Modulation depth range:	0 to 70%, usable to 85%.
Frequency range:	50 Hz to 15 kHz.
Sensitivity:	50 Hz to 5 kHz, up to 60% AM:– 1.5 V p–p for 30% AM ±10% ±1% AM. 50 Hz to 15 kHz, up to 70% AM:– 1.5 V p–p for 30% AM ±15% ±1% AM.
AM distortion:	<2% distortion at 1 kHz with 30% AM in a 300 Hz to 3.4 kHz bandwidth.

Frequency modulation

CW range:	0.4 to 1000 MHz.
Deviation range:	0 to 25 kHz.
Modulation frequency range:	50 Hz to 15 kHz.
Resolution:	25 Hz (<6.25 kHz deviation). 100 Hz (<25 kHz deviation).
Indication:	4 digits.
Setting:	Keyboard entry. Step change variation by increment/ decrement keys and rotary control.

Accuracy:	±7% ±10 Hz (at 1 kHz). ±10% (50 Hz to 15 kHz).

FM external input

Input impedance:	1 MΩ in parallel with approximately 40 pF.
CW range:	0.4 to 1000 MHz.
Deviation range:	0 to 30 kHz deviation.
Modulation frequency range:	1 Hz to 50 kHz.
Sensitivity:	1 V p-p for 5 kHz deviation ±10% to 1 kHz.
FM distortion:	<1% distortion at 1 kHz with 5 kHz deviation in a 300 Hz to 3.4 kHz bandwidth.

Phase modulation

CW range:	0.4 to 1000 MHz.
Deviation range:	0 to 10 rad.
Modulation frequency range:	300 Hz to 3.4 kHz.
Resolution:	0.02/0.03 rad, up to 6.3 rad.
Indication:	3 digits.
Setting:	Keyboard entry. Step change variation by increment/ decrement keys and rotary control.
Accuracy:	±8% at 1 kHz, ±11% from 300 Hz to 3.4 kHz.
Distortion:	<2% at 1 kHz with 5 rad measured in a 300 Hz to 3.4 kHz bandwidth.

ΦM external input

Input impedance:	1 MΩ in parallel with approximately 40 pF.
Deviation range:	0 to 10 rad.
Frequency range:	300 Hz to 3.4 kHz.
Sensitivity:	1 V p-p for 5 rad at ±12% at 1 kHz.
ΦM distortion:	<2% at 1 kHz with 5 rads, measured in a 300 Hz to 3.4 kHz bandwidth.

Audio generator and 1 kHz oscillator section

Output impedance: 5 Ω nominal.

Frequency

Range:	50 Hz to 15 kHz (usable 20 Hz to 20 kHz).
Resolution:	0.1 Hz from 20 Hz to 3.25 kHz. 1 Hz from 3.25 kHz to 20 kHz.
Indication:	5 digits.
Setting:	Keyboard entry. Step change variation by increment/decrement keys and rotary control.
Accuracy:	±0.01 Hz from 50 Hz to 3.25 kHz. ±0.1 Hz from 3.25 kHz to 15 kHz.

Signal purity

Distortion:	<2% up to 15 kHz.
Spurious signals:	<–26 dBc (at 9370 Hz >20 Hz only).
Residual noise:	<0.2 mV RMS in a psophometric bandwidth.
DC offset:	<100 mV DC.

Fixed frequency: 1 kHz.

Accuracy:	As internal standard.
Distortion:	<1%.
Residual noise:	<0.4 mV RMS in a psophometric bandwidth.
DC offset:	<100 mV DC.

Two-tone setting: Two tones are available, 1 kHz and the AF generator frequency setting, both at the same level.

Output level (EMF)

Range:	1 mV to 2.55 V up to 5 kHz. 1 mV to 2 V up to 15 kHz.
Accuracy:	±5% ±1 count 50 Hz to 15 kHz.
Setting:	1 mV steps from 1 mV to 255 mV. 2.5 mV steps from 255 mV to 635 mV. 10 mV steps from 640 mV to 2.55 V.

RF counter section

Frequency

Range:	1.5 to 1000 MHz.
Resolution:	1 Hz or 10 Hz to 200 MHz, 10 Hz from 200 MHz to 1000 MHz.
Accuracy:	As internal standard ±1 digit.

Input

Impedance:	50 Ω nominal	
VSWR:	N socket;	<1.2:1 to 500 MHz. <1.35:1 to 1000 MHz.
	BNC socket;	<2.2:1 to 1000 MHz typical.
Sensitivity:	N socket;	5 mW (0.5 V), TX mode selected. 20 mW (1 V), one/two port duplex.
	BNC socket;	0.05 mW (50 mV).
Update time:	100 ms for frequencies up to 200 MHz with 10 Hz resolution. 1 s with 1 Hz resolution. 400 ms for frequencies up to 1000 MHz with 10 Hz resolution only.	

RF power meter section

Input

Impedance:	As RF counter section.		
VSWR:	As RF counter section.		
Reading ranges:	N socket;	TX mode	50 mW to 150 W, usable down to 5 mW.
		One-port duplex	100 mW to 150 W, usable down to 20 mW.
		Two-port duplex	50 mW to 100 W, usable down to 5 mW.
	BNC socket;		0.05 mW to 1.0 W.
Continuous rating:	75 W at 0 to 50°C.		

Maximum input:	N socket; 150 W (TX mode or one-port duplex) or 100 W (two-port duplex) for limited period, typically 2 minutes at 25°C. End of usable working period indicated by visual warning (REMOVE RF INPUT) and audible alarm. BNC socket; 1.2 W. Trip circuit operates at approximately 1.0 W. Overload protection up to 50 W. Tripping indicated by visual warning (REMOVE RF INPUT) and audible alarm.
Frequency range:	1.5 to 1000 MHz.
Resolution:	1% of indicated bar chart range.
Indication:	2 or 3 digits and analogue display.
Setting:	Automatic ranging on scales 0 to 30, 0 to 100, 0 to 300 mW; 0 to 1, 0 to 3, 0 to 10, 0 to 30, 0 to 100, 0 to 300 W.
Acquisition time:	<3 s with 10 Hz resolution.
Accuracy:	±10% ±1 digit up to 500 MHz. ±15% ±1 digit up to 960 MHz. ±20% ±1 digit up to 1000 MHz. ±1.25 dB ±1 digit ≥5 mW over the ranges 825 to 845 MHz and 890 to 905 MHz from +15°C to +25°C. (There may be a difference between a TX mode reading and a duplex mode reading. The difference is normal and within the above limits.)

Modulation meter section

Input

Manual tune:	Provides frequency offset indication from carrier, 3 digits and decimal point. Indicates most significant positive or negative error.
Auto tune:	Provides measurement and simultaneous display of RF frequency, RF power, modulation frequency and level.
Sensitivity:	N socket; 5 mW (0.5 V), TX mode selected. 20 mW (1 V), single port duplex. BNC socket; 0.05 mW (50 mV).
Acquisition time:	<3 s with 10 Hz resolution.
AF filters available:	Band-pass – 300 Hz to 3.4 kHz. Low-pass – 300 Hz or 15 kHz.

Amplitude modulation

CW range:	1.5 to 400 MHz.
Modulation depth range:	0 to 90% below 100 MHz. 0 to 80% from 100 to 400 MHz. Usable to 100% when manually tuned. Automatic ranging (bar chart), 0 to 10, 0 to 30, 0 to 100% depth.
Modulation frequency range:	50 Hz to 10 kHz (usable from 10 Hz to 15 kHz).
Resolution:	1% AM.
Indication:	2 digits and ± peak analogue display.
Accuracy:	±6% ±1 digit at 1 kHz. ±8.5% ±1 digit from 50 Hz to 10 kHz.
Demodulation distortion:	At 30% AM and 1 kHz modulation frequency, 300 Hz to 3.4 kHz bandwidth:- <2% at 21 MHz carrier and above. <5% up to 21 MHz carrier.
Residual AM:	<1%, 300 Hz to 3.4 kHz bandwidth.

Frequency modulation

CW range:	1.5 to 1000 MHz.
Deviation range:	0 to 25 kHz (30 kHz on scope). Automatic ranging (bar chart), 0 to 1, 0 to 3, 0 to 10, 0 to 30 kHz.
Modulation frequency range:	50 Hz to 10 kHz (typically 10 Hz to 15 kHz).
Resolution:	10 Hz up to 2.5 kHz deviation. 1% up to 25 kHz deviation.
Indication:	3 digits and ± peak analogue display.
Accuracy:	±6% ±1 digit at 1 kHz. ±8.5% ±1 digit over range 50 Hz to 10 kHz.
Demodulation distortion:	<2% distortion at 5 kHz deviation and 1 kHz modulation frequency in a 300 Hz to 3.4 kHz bandwidth.
Residual FM:	For inputs above 20 mW/0.2 mW (N/BNC) in a 300 Hz to 3.4 kHz bandwidth:- <30 Hz RMS (typically 15 Hz) up to 500 MHz. <60 Hz RMS (typically 30 Hz) up to 1000 MHz.

Phase modulation

CW range:	1.5 to 1000 MHz.
Deviation range:	0 to 10 rad. Automatic ranging (bar chart), 0 to 1, 0 to 3, 0 to 10 rad.
Modulation frequency range:	300 Hz to 3.4 kHz (with respect to 750 µs de-emphasis).
Resolution:	1% or 0.01 rad.
Indication:	3 digits and ± peak analogue display.
Accuracy:	±6% ±1 digit at 1 kHz. ±8.5% ±1 digit from 300 Hz to 3.4 kHz.
Demodulation distortion:	<2% at 5 rad and 1 kHz modulation frequency in a 300 Hz to 3.4 kHz bandwidth.

SINAD and S/N meter section

General

Frequency:	1 kHz.
Range:	0 to 18 dB, 0 to 50 dB (SINAD). 0 to 30, 0 to 100 dB (S/N).
Resolution:	0.1 dB.
Indication:	3 digits plus analogue display.
Accuracy:	±1 dB.
Sensitivity:	50 mV (100 mV for 40 dB SINAD or S/N).

Note ...

For SINAD and S/N measurements, residual FM has to be taken into account.

Distortion meter section

General

Frequency:	1 kHz.
Range:	0 to 10%, 0 to 30% distortion.
Resolution:	0.1% distortion.
Indication:	3 digits and analogue display.

Accuracy:	±5% of reading ±0.5% distortion.
Sensitivity:	50 mV (100 mV for 1% distortion).

Note ...

For distortion measurements, residual FM has to be taken into account.

AF voltmeter section

General

Input impedance:	1 MΩ in parallel with approximately 40 pF.
Frequency range:	50 Hz to 20 kHz (or DC), usable 20 Hz to 50 kHz.
Level range:	0 to 100 mV, 0 to 300 mV; 0 to 1, 0 to 3, 0 to 10, 0 to 30, 0 to 100 V.
Resolution:	1 mV or 1% dependent on range.
Indication:	3 digits plus analogue display.
Accuracy:	±3% of reading ±3 mV ±1 digit.
Frequency response:	Switchable; band-pass 300 Hz to 3.4 kHz, low-pass 300 Hz or 50 kHz.

AF counter section

General

Range:	20 Hz to 20 kHz.
Resolution:	0.1 Hz or 1 Hz.
Indication:	3, 4 or 5 digits.
Accuracy:	As internal standard ±1 digit, ±0.1 Hz or 0.02% (whichever is greater).
Sensitivity:	50 mV.

Internal frequency standard

OCXO

Normal frequency:	10 MHz.
Temperature coefficient:	<±5 parts in 10^8 from 5 to 55°C. <±4 parts in 10^9 from 50 to 70°C.

Aging rate:	<±1 part in 107/month. <±1 part in 106/year after 1 month's continuous use.
Short-term stability:	<±1 part in 109, RMS frequency error over a 1 s period.
Retrace error:	<±2 parts in 107 over 24 hours, at constant temperature and after 25 minutes warm-up.

External frequency standard

Range:	1 MHz ±5 Hz.

Digital storage oscilloscope

General	Single or repetitive sweep. Available in TX, RX and audio test modes, calibrated for AM, FM and ΦM. For viewing demodulated audio (plus external input option).
Frequency range:	DC to 50 kHz (from 3 Hz on AC).
Voltage range:	10 mV/div to 20 V/div in 1–2–5 sequence.
Accuracy:	±5%.
AM ranges:	20, 10, 5%/div at ±10% accuracy.
FM ranges:	±30, 15, 6, 1.5 kHz deviation at ±10% accuracy.
ΦM ranges:	±15, 7.5, 3, 1.5 rad at ±10% accuracy.
Sweep rates:	100 µs/div to 5 s/div in 1–2–5 sequence accuracy locked to internal standard.
Trigger:	Repetitive, or single shot storage.

Other features

Battery option:	16 V, capacity 7 Ah. Normal usage life, 1.5 h.
GPIB option:	All functions except the supply switch and analogue controls are remotely programmable.
Capabilities:	Complies with the following subsets as defined in IEEE 488–1978: SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E1.
Selcall decoder and encoder:	Decodes up to 12 tones and encodes up to 11 tones in a CCIR, ZVEI, DZVEI, EEA, EIA or user-defined tone sequence.

Tone decoder facilities:	Display tone number, frequency and percentage error. Screen indicates null tones (using CRT) and annotates out-of-limit frequencies.
Tone encoder facilities:	Send continuous, burst, single step, extend 5th from last tone; null, repeat or frequency shift up to ±9 % in 1% steps.
User-defined:	Allows definition for decode or encode of up to 15 tones. Frequency range is 300 Hz to 3.4 kHz (decode) and 20 Hz to 20 kHz (encode) with a duration of 25 ms to 1.2 s (decode) and 10 to 999 ms (encode). Up to a maximum of 12 tones may be received and a maximum of 11 tones may be sent at any one time. Frequencies are retained in non-volatile memory.
Two-tone modulation:	In TX mode, using tones menu, generates 1 kHz fixed plus that from the AF generator. In RX mode, external modulation inputs add to internal modulation.

IF output socket

Frequency:	110 kHz nominal.
Level:	180 mV minimum.
Impendance:	50 Ω, maximum load 5 kΩ.
Bandwidth:	50 kHz to over 350 kHz.

External standard input socket

Frequency:	1 MHz.
Level:	100 mV to 3 V RMS.
Impedance:	10 kΩ in parallel with approximately 100 pF.
Demodulation output socket:	For listening to demodulated output and AF input.
Level:	400 mV p-p for ±1 kHz deviation, ±10%.
Impedance:	10 kΩ nominal.
Bandwidth:	300 Hz to 3.4 kHz band-pass. 300 Hz low-pass or 15 kHz low-pass selected by front panel filter switch.
Accessory socket:	Pins 1, 3, 4, 5, 6, 7 designed for future options. Pin 2, +12 V at approximately 100 mA. Pin 7, AF output, 1 W into 8 Ω. Pin 1, pulse output available under GPIB control, approximately 600 ns.

General

Power requirements

Rated supply voltage:	105 to 120 V AC ±10%. 210 to 240 V AC ±10%.
Supply frequency range:	45 to 440 Hz.
Maximum consumption:	100 VA.
DC supply voltage:	11 to 32 V DC.
DC supply consumption:	<60 W.

Radio frequency interference: Conforms with the requirements of EEC Directive 76/889 as to limits of RF interference.

Safety: Complies with IEC 348.

Rated range of use: 0 to 50°C.

Limit range of operation: 0 to 55°C.

Conditions of storage and transport

Temperature:	–40°C to +70°C.
Humidity:	Up to 90% humidity.
Altitude:	Up to 2500 m (pressurized freight at 27 kPa differential, i.e. 3.9 lbf/in²).

Dimensions and weight: Including handle, feet and cover –
Height: 197 mm (7.75 in)
Width: 389 mm (15.3 in)
Depth: 584 mm (23.0 in)
Weight: 15.5 kg (34 lb).

ACCESSORIES

Supplied

	Part no.
Polythene cover	37490–738D
Stowage cover	41690–411S
Mains input lead	43129–003W
DC input lead assembly	43130–119U
Operating Manual H 52995–900A Vol. 1	46881–622N

Optional

Battery pack (with charger)	54462–023W
Battery pack (without charger)	54462–024D
Lead assembly, BNC connectors, 1.5 m	43126–012S
Lead assembly, N connectors, 1.0 m	54311–095C
Lead assembly, BNC connectors, 1.0 m (double screened for enhanced RFI performance)	43137–052Y
Lead assembly, DIN 7–way connectors, 1.0 m	43130–590R
Lead assembly, DIN 7–way connectors, 3.0 m	43130–591B
Viewing hood assembly	54150–022P
GPIB interface unit	54433–002Y
GPIB adapter, IEEE male to IEC female	46883–408K
GPIB lead assembly, IEEE connectors	43129–189U
GPIB lead assembly, IEEE connectors, 1.0 m (double screened for enhanced RFI performance)	46883–962H
Aerial, telescopic, BNC	54421–001N
RF directional power head, 1 to 50 MHz	54421–002L
RF directional power head, 25 to 1000 MHz	54421–003J
Psophometric CCITT filter	54499–042L
Psophometric CMESS filter	54499–043J
20 dB AF attenuator	54431–023A
600 Ω balanced to unbalanced convertor and 20 dB attenuator	54411–052M
IF probe 455 kHz	54451–165L
IF probe 470 kHz	54451–163Y
IF probe 10.7 MHz	54451–164N
Printer	54211–001D
Printer accessory kit (2 paper rolls and ribbon cartridge)	46883–877P
Printer Manual H 54211–001D	46881–645A
Extender board kit	46883–725U
Rack mounting kit	54127–304C
Transit case	46662–192W
Service Manual H 52955–900A Vol. 2	46881–504C
GPIB Manual H 54811–010P	46881–365R
Primary pack	37136–513F

Chapter 2
INSTALLATION

UNPACKING AND REPACKING

Retain the container, packing material and the packing instruction note (if included) in case it is necessary to reship the instrument.

If the instrument is to be returned for servicing, attach a label indicating the service required, type or model number (on rear label), serial number and your return address. Pack the instrument in accordance with the with the more detailed information which is given in the packing instruction note or as follows:–

(1) Place mains lead in suitable plastic bag and tape it to the instrument rear panel.

(2) Place the instrument within its plastic cover.

(3) Ensure that the padded fitting is in place within the inner carton and slide the instrument in, rear panel first, leaving the front panel exposed at the open end.

(4) Fit the separate front panel protecting cover over the panel and close and seal the inner carton.

(5) Place one of the moulded plastic cushions in the bottom of the outer carton and insert the inner carton so that it locates in the cushion recess.

(6) Place the remaining plastic cushion over the other end of the inner carton and close and seal the outer carton.

(7) Wrap the container in waterproof paper and secure with adhesive tape.

(8) Mark the package FRAGILE to encourage careful handling.

Note ...

If the original container or materials are not available, use a strong double–wall carton packed with a 7 to 10 cm layer of shock absorbing material around all sides of the instrument to hold it firmly. Protect the front panel controls with a plywood or cardboard load spreader. If the rear panel has guard plates or other projections, a rear load spreader is also advisable.

MOUNTING ARRANGEMENTS

Excessive temperature may affect the instrument's performance; therefore, completely remove the plastic cover, if one is supplied over the case, and avoid standing the instrument on or close to other equipment that is hot.

RACK MOUNTING

The instrument may be mounted in a 19 inch rack using the kit available as an optional accessory. Fitting instructions are as follows:–

(1) Removal of instrument feet may be carried out without removing the bottom cover. Ease the centre bungs from the feet to expose the retaining screws which are held in captive nuts.

(2) The front panel stowage cover is held in position by two strike plates located at the front of the case side rails. These are attached by self tapping screws and have to be removed.

(3) To remove the instrument handle, first pull off the brown plastic caps at the ends of the handle side arms. Next remove the exposed central retaining screws from either side.

(4) Fit the rack brackets securing with an M5 x 16 pan head screw and washer, as supplied, on either side. These screws fit into the position formerly occupied by the handle retaining screws.

Note ...

Ensure adequate outlet for the blown air cooling system.

FITTING THE BATTERY OPTION

The external battery pack, available as an optional accessory, is mounted on top of the instrument as follows:–

(1) Position the battery pack above the instrument and fit the projecting lugs at the rear of the battery pack (tilting as necessary) into the slots in the instrument's rear feet.

(2) Secure the pack in place by passing the carrying strap around the body of the instrument then pulling the strap through the friction buckle until tight. Hold the remaining strap length in place using the Velcro fastener.

(3) To release, press the friction bar to unclamp the strap then ease the lugs out of the rear feet.

(4) Unclip the connector by pressing on its sides to release it from its storage point, and pull out the attached lead from the case. Reclip the connector to the DC SUPPLY socket on the rear panel.

SAFETY TESTING

Where safety tests on the AC supply input circuit are required, the following procedures can be applied. These comply with BS 4743 and IEC Publication 348. Tests are to be carried out a follows and in the order given, under ambient conditions, to ensure that AC supply input circuit components and wiring (including earthing) are safe.

(1) Earth lead continuity test from any part of the metal frame to the bared end of the flexible lead for the earth pin of the user's AC supply plug. Preferably a heavy current (about 25A) should be applied for not more than 5 seconds.

Test limit: not greater than 0.5 Ω.

(2) 500 V DC insulation test from the AC supply circuit to earth.

Test limit: not less than 2 MΩ.

POWER SUPPLY REQUIREMENTS

The instrument may be operated from AC mains or from an external battery pack.

AC power supply

For AC operation, the instrument requires 105 to 120 V or 210 to 240 V, 50 to 400 Hz, 100 VA. The required supply fuses (time lag) are 1A for 105 to 120 V or 500 mA for 210 to 240 V. Before switching on, ensure that the rear panel voltage range switch is in its correct position as revealed by the cut-out in the locking plate, and that the correct value fuses are fitted. To change the mains voltage setting, reverse the locking plate after setting the slide switch to its alternative position.

The AC supply cable is fitted at one end with a female plug which mates with the AC connector at the rear of the instrument. When fitting a supply plug, ensure that the connections are as follows:-

Earth (ground)	-	Green/Yellow
Neutral	-	Blue
Live (phase)	-	Brown

When attaching the mains lead to a non-soldered plug, it is recommended that the tinned ends of the lead are first cut off to avoid the danger of cold flow resulting in intermittent connection.

DC power supply

For DC operation, a 16 V, 7 Ah rechargeable nickel cadmium battery pack is available as an optional accessory. The battery is protected by a time-lag 6.3 A fuse. Remove the battery lead from its stowage and connect to the DC SUPPLY socket on the instrument rear panel. With a fully-charged battery, operating time is in excess of 1 hour.

Alternatively, an external DC supply of between 11 V and 32 V and able to supply approximately 55 W may be used. Connect the battery leads to the rear panel DC SUPPLY socket ensuring that polarities are correct.

AC and DC operation

If both the DC supply and the AC supply are connected, the instrument automatically selects AC power. If the AC power is then removed, the instrument switches to DC with no interruption of operation. In certain circumstances, the external power supply may not be able to take the sudden change in load and its inbuilt protection, e.g. current feedback limiting, may switch off the supply. This can normally be prevented by setting the DC supply to around 20 V. There should be no problems with units able to supply 32 V at approx. 4 mA.

To protect the +12 V power supply to board AC1, an in-line fuse has been fitted between boards AC1 and AB1. The fuse is 1.6 A time-lag. Access to it is gained after removal of the upper half of the case. The fuse is located adjacent to the grey box of the crystal oscillator.

GENERAL PURPOSE INTERFACE BUS

Fitting instructions

The GPIB interface unit is an optional accessory which can be fitted by the user as follows:–

(1) Remove the top cover of the instrument after removing four screws.

(2) The GPIB interface unit goes in the rectangular cut–out in the rear panel. If the unit may be subjected to severe stress or vibration, fit the optional GPIB bracket to the unit.

(3) Remove the cut–out cover plate, insert the unit (with bracket if required) and secure it in place with the two screws that formerly retained the cover plate.

(4) Connect the unit into circuit by engaging its free socket with the plug on motherboard AB1.

(5) Replace the top cover.

(6) The unit is ready for GPIB operation after setting the appropriate talker/listener address on the rocker switch bank. See Fig. 3–13.

GPIB cable connection

Connection to other equipment which has an IEEE 488 24–way connector can be made with the GPIB lead assembly 43129–189U, available as an optional accessory. An IEEE–to–IEC adapter 46883–408K is also available for connecting to systems using a 25–way bus connector to IEC 625 as shown in Fig. 2–1 below. Where conformity with the radio frequency interference limits specified by VDE (Verband Deutscher Electrotechniker) is required, a double–screened lead assembly 46883–962H is available as an optional accessory.

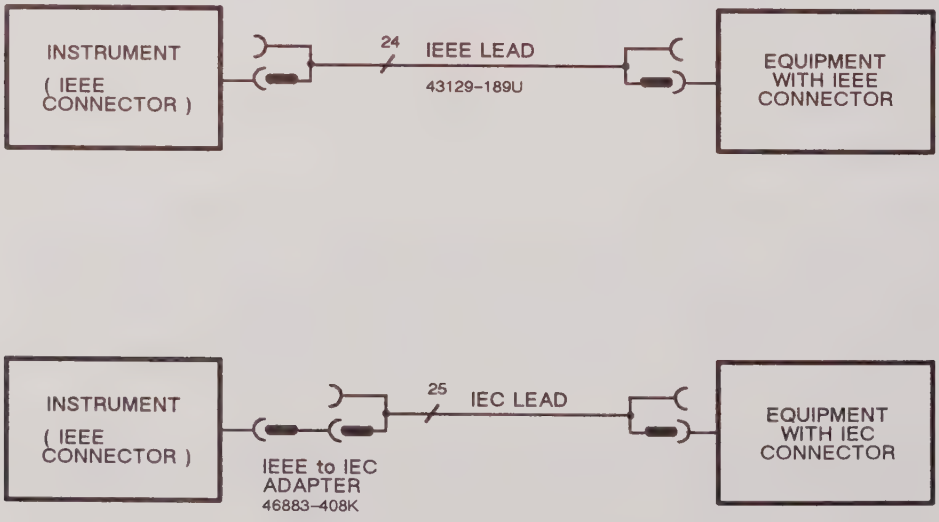


Fig. 2–1 GPIB interconnections

GPIB connector contacts

The contacts on the GPIB cable connector and the device connector is as shown in Fig. 2–2 below.

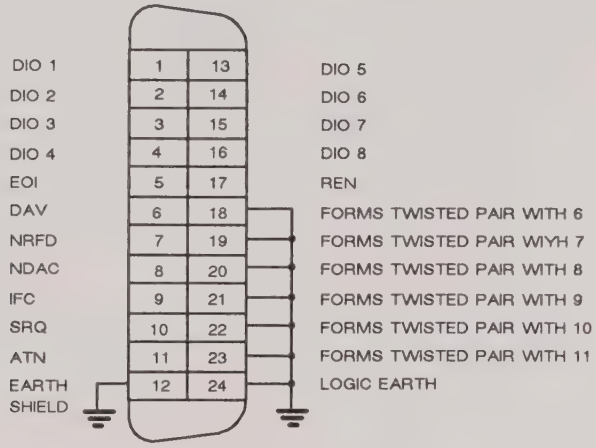


Fig. 2–2 GPIB connector contacts

The cables have special male–female connectors at both ends. This allows several connectors to be stacked one on top of another permitting several cables to be connected to the same source and secured by a lockscrew mechanism. Too large a stack however, may form a centilevered structure which might cause damage and should be avoided. The piggyback arrangement permits star or linear interconnection between the devices forming a system with the restriction that the total cable length for the system is as follows:–

(1) No greater than 20 m (65 ft).

(2) No greater than 2 m (6 ft) times the total number of devices (including the controller) connected to the bus.

ACCESSORY SOCKET

The contact numbering of the 7-way DIN socket is shown in Fig. 2–3. Reading clockwise from the earth shield locating spigot, the functions in position order are as follows:–

Position	Pin	Function
1	6	Logic
2	1	Logic
3	4	Forward power
4	2	+12 V DC at approx 100 mA
5	5	Reverse power
6	3	Logic
7	7	Demodulated output

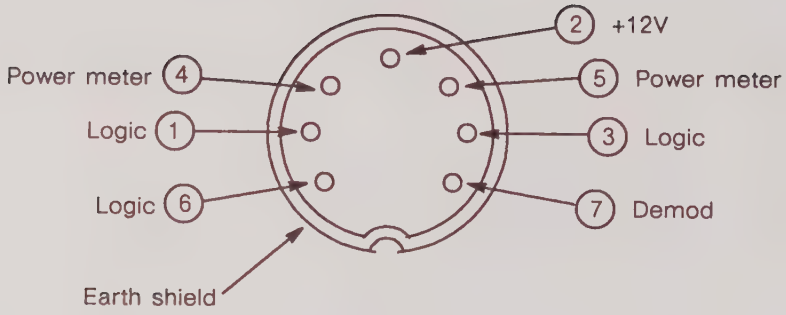


Fig. 2–3 ACCESSORY socket contacts (as viewed from the front)

Selection logic on contacts 6, 1 and 3 enable the instrument to detect and recognise the connection of an external accessory. The appropriate contacts are at TTL levels and are active low (L) as follows:–

Accessory	6	1	3
Nothing connected	H	H	H
Headset (press to talk)	L	L	H
External power: Auto zero	L	H	L
External power: Peak power	L	H	H
External power: RMS power	H	H	L
Psophometric filter: C-MESS	H	L	L
Psophometric filter: CCITT	H	L	H
Spare	L	L	L

A 3.0 m lead assembly 44990–814K is available as an optional accessory.

RF IN/OUT SOCKET

Where conformity with the radio frequency interference limits specified by VDE (Verband Deutscher Electrotechniker) is required, a double-screened lead assembly 43137–052Y is available as an optional accessory.

Chapter 3
OPERATION

Following power-up conditions and a summary of the front and rear panel controls and connectors, each of the main functions of the instrument is separately detailed in this chapter. The main functions are arranged under the headings of transmitter testing, receiver testing, duplex testing and tones decoding and encoding. Additional operating information is provided upon pressing the HELP key; details are given under 'HELP Key Operation'. To obtain familiarity with the instrument, follow the operating sequences given under 'AF Generator Operation' and 'Signal Generator Operation'; these involve detailed keyboard operations for transmitter and receiver testing respectively.

INITIAL SETTINGS

When switched on, the instrument automatically enters and displays the following set conditions:-

Condition	Setting
Mode	RX
RF generator frequency	300 MHz
RF generator level	-100 dBm
Modulation frequency	1 kHz
Modulation level	FM 1.5 Hz
Filter	0.3-3.4 Hz
Connector	N socket

SELF TEST

At any time, following a period after switch-on to allow the frequency standard to stabilize (typically 5 minutes), the instrument may be self-tested. This facility is entered using the HELP key. Operating details are given under 'HELP Key Operation'.

SELECTING MEASUREMENT MODE

Once the instrument displays its initial settings, you can select the required measurement, usually in three steps as follows:-

(1) Select mode, e.g. TX, RX, Tones - BLUE key.

(2) Select function, e.g. AF Gen, Set Modulation- GREEN key.

(3) Enter data for frequency, level etc - ORANGE and WHITE keys.

Changing from one measurement to another is by simple key operation. For details of the use and operation of the controls for each measurement, see under the relevant heading, e.g. to measure transmitter power, see under 'RF Power Meter'.

When the operation of a control appears to cause an unusual response or a lack of it, the reason may be found by checking through the manual for other references to that control. For example, the AC DC key sometimes does not select DC. Checking through the manual reveals that this key is disabled for both SINAD and distortion measurements. In this case, selecting DIST'N OFF re-enables the key for other measurements.

FRONT PANEL

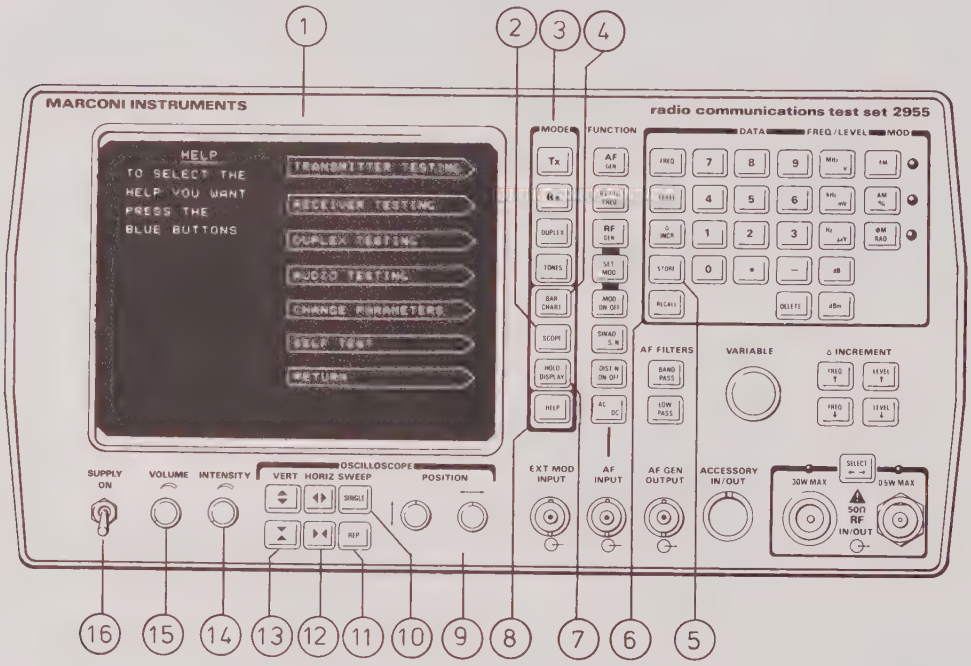


Fig. 3–1 Front panel

(1) **Display.** This shows one of the following:-

(a) Instrument settings and measurement results (in the upper half of the screen) with bar charts or an oscilloscope graticule and trace (in the bottom half of the screen.

(b) One of the menus for using the seven blue keys (2), (3), (4) and (7) as soft keys to select a programmed function.

Under difficult viewing conditions, the viewing hood assembly 54150–022P, available as an optional accessory, may be used. This folding assembly clips under the screen bezel.

(2) **SCOPE key.** When this is selected, the bottom half of the screen shows a single trace on a graticule of 6 x 10 squares. The trace is of the demodulated audio in transmitter testing and of the applied audio in receiver testing. Also, this is used as a soft key to select a programmed function from menus which are shown alongside on the screen.

(3) **MODE keys.** These are used to select transmitter testing, receiver testing, duplex testing or tones testing. Also, these are used as soft keys to select programmed functions from menus which are shown alongside on the screen.

(4) **BAR CHART key**. When this is selected, the bottom half of the screen shows vertical bar charts. Also, this is used as a soft key to select a programmed function from menus which are shown alongside on the screen.

(5) **STORE key.** Stores all front panel settings except those of the analogue controls such as intensity, volume, etc. It is followed by a 2–digit number in the range 01 to 37 to identify the stored setting. Store 00 is automatically allocated to the instrument setting at switch–off or loss of mains or battery power.

(6) **RECALL key.** When followed by a 2–digit number, recalls the front panel setting previously stored using (5). When followed by 00, restores the instrument settings to those set at the time of switch–off etc.

(7) **HOLD DISPLAY key.** Freezes the display including the oscilloscope or bar charts (but not the trace). All the front panel keys except HOLD DISPLAY are inoperable. When the key is pressed again, the hold is released. Also, this is used as a soft key to select a programmed function from menus which are shown alongside on the screen.

(8) **HELP key.** Displays the HELP menu. See under 'HELP Key Operation'.

(9) **POSITION controls.** Used to vary the trace position, both horizontally and vertically.

(10) **SINGLE SWEEP key.** Allows only one sweep of the oscilloscope trace to occur after a trigger and implements the storage oscilloscope facility. Resets the sweep if it is part way through.

(11) **REP SWEEP key.** Repetitively sweeps the oscilloscope trace on auto trigger.

(12) **HORIZ key.** Changes the oscilloscope horizontal scale time per division.

(13) **VERT keys.** In TX mode, these change the oscilloscope vertical scale in modulation units per division. In RX mode, they change the oscilloscope vertical scale in volts per division.

(14) **INTENSITY control.** Varies the brightness of the display.

(15) **VOLUME control.** Controls the output of the built–in loudspeaker which is used for monitoring and for alarms.

(16) **SUPPLY switch.** When it is switched to ON, the instrument enters the RX mode.

REAR PANEL

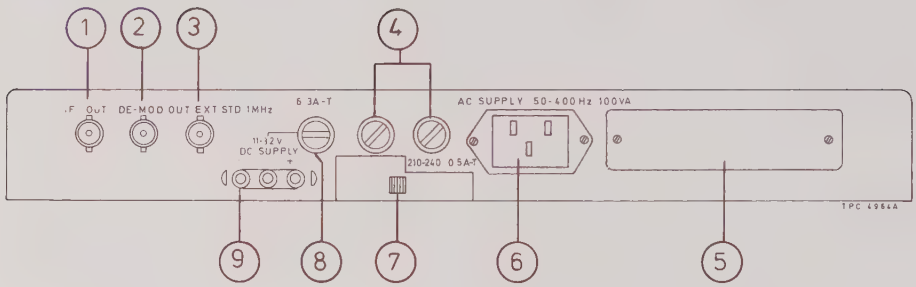


Fig. 3–2 Rear panel

① **IF OUT SOCKET.** BNC socket supplying a 110 ±10 kHz IF output. Do not load with less than 10 kΩ.

② **DE-MOD OUT socket.** BNC socket supplying a demodulated output from the modulation meter. Do not load with less than 10 kΩ.

③ **EXT STD 1 MHz socket.** BNC socket for the connection of an external 1 MHz standard. Connection automatically phase locks the internal standard to the external signal.

④ **AC supply fuses.** Time delay, cartridge type, for fusing ⑥. For details, see Chap. 2, Installation.

⑤ **GPIB interface access.** Enables the optional GPIB interface unit to be fitted for remote instrument operation. For fitting instructions, see Chap. 2, Installation.

⑥ **AC supply connector.** 3-pin AC supply input connector.

⑦ **Supply voltage selector.** To change the range.

⑧ **DC supply fuse.** Time delay, cartridge type, for fusing ⑨. For details, see Chap. 2, Installation.

⑨ **DC supply socket.** 3-pin socket for connection to an optional battery unit or to an external battery. For fitting a battery pack and for operating details, see Chap. 2, Installation.

TRANSMITTER TESTING

AF GENERATOR

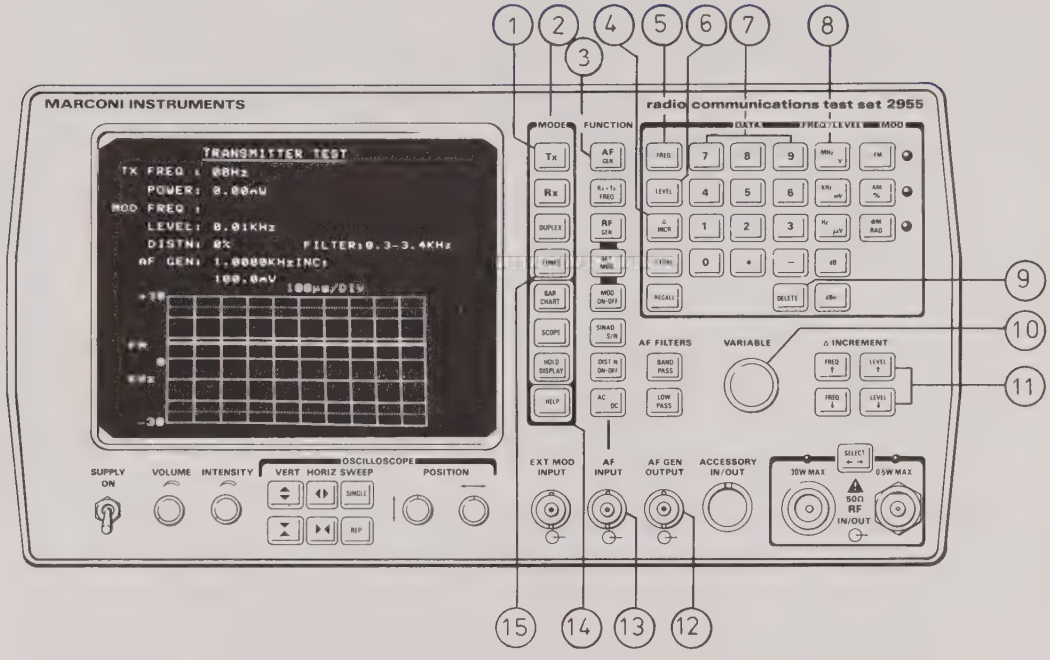


Fig. 3–3 AF generator controls and connectors

(1) **TX key.** Connects the AF generator to the AF GEN OUTPUT socket (12). Writes on the screen information concerning instrument setting.

(2) **MODE keys.** Used as soft keys to select programmed functions when menus are shown alongside on the screen.

(3) **AF GEN key.** Enables the internal AF generator.

(4) **Δ INCR key.** Follows a FREQ (5) or LEVEL (6) entry so that the entered data is recognized as an increment or decrement.

(5) **FREQ key.** Precedes a keypad (7) entry so that the entered data is recognized as a frequency.

(6) **LEVEL key.** Precedes a keypad (7) entry so that the entered data is recognized as a level.

(7) **DATA keypad.** For data entry using numerals 0 to 9, decimal point and minus sign.

(8) **FREQ/LEVEL keys.** For defining units of frequency or level. One of these terminates the data entry.

(9) **DELETE key.** Deletes a preceding digit, decimal point or minus sign entered on (7).

(10) **VARIABLE control.** Analogue control which varies the smallest increment of the function data. Step size is independent of (4) and depends upon range. The level or frequency assignment is shown in reverse field on the screen.

(11) **Δ INCREMENT keys.** Implement the increment (up arrow) key and decrement (down arrow) key in frequency or level in the step size set using (4).

(12) **AF GEN OUTPUT socket.** BNC connector supplying an output in the range 20 Hz to 20 kHz for single tone operation plus a fixed 1 kHz for two tone operation. Impedance 5 Ω.

(13) **AF INPUT socket.** BNC socket for the optional 600 dBm accessory.

(14) **HELP key.** Used to select the 20 dB attenuator and 600 dBm accessory as described under 'HELP Key Operation'.

(15) **TONES key.** Used to select two tone operation.

AF generator operation

AF generator operation is detailed under frequency and level.

(1) Select mode TX (1). TRANSMITTER TEST is written on the screen.

(2) Select function AF GEN (3). AF GEN is shown in reverse field on the screen.

(3) Connect the unit under test to the AF GEN OUTPUT socket (12).

(4) To use the optional 600 Ω dBm accessory, e.g. for testing telephone lines, connect this unit between AF GEN OUTPUT (12) and the AF INPUT (13) sockets. To change the AF voltage readings to dBm (into 600 Ω) use the 'Change Parameters' function. When this is selected, dBm appears in place of voltage. The accessory also provides a 20 dB attenuated output which is also selectable in the 'Change Parameters' function. When this option is selected, a reverse video A is displayed.

Frequency

To tune the AF generator frequency, proceed as follows:-

(5) Select FREQ (5). The frequency to be changed is shown in reverse field. Enter the data on the keypad (7), ending with the frequency terminator (8), e.g.

for 1.235 kHz, enter the following:-

If a mistake is made during data entry, press DELETE (9) and then enter the correct character. When, however, the terminator (8) has been pressed, re-enter the complete data. If incorrect data has been entered, e.g. a frequency outside the range of the instrument, the terminator is ignored and the entry is not be accepted. Use DELETE and then re-enter the data.

(6) If required, set the frequency increment/decrement by selecting Δ INCR (4) and entering the data, ending with the frequency terminator, e.g. for 500 Hz steps, enter the following:-

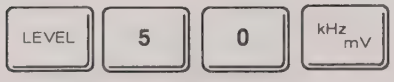
In the example, FREQ may be omitted since it has been previously entered in (5).

(7) Having set the step size, the frequency may be adjusted by repeatedly pressing one of the Δ INCREMENT keys (11), FREQ ↑ for an increment or FREQ ↓ for a decrement. For fine frequency control, use the VARIABLE control (10).

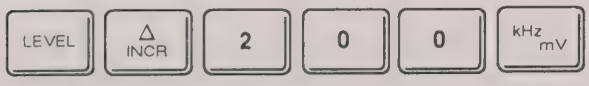
Level

To adjust the AF generator level, proceed as follows:-

(8) Select LEVEL (6). The level to be changed is displayed in reverse field. Enter the data on the keypad (7), ending with the level terminator (8), e.g. for 50 mV, enter the following:-



(9) If required, set the level increment/decrement by selecting Δ INCR (4) and entering the data, ending with the level terminator, e.g. for 200 mV steps, enter the following:-



In the example, LEVEL may be omitted since it has been previously entered in (8).

(10) Having set the step size, the level may be adjusted by repeatedly pressing one of the Δ INCREMENT keys (11), LEVEL ↑ for an increment or LEVEL ↓ for a decrement. For fine level control, use the VARIABLE control (10).

(11) To use the optional 20 dB attenuator, connect the unit to the AF GEN OUTPUT socket (12). Press the HELP key (14) and then continue by following 'HELP Key Operation'. When the accessory is selected, a reverse field A is displayed and the displayed AF generator level is decreased by a factor of 10 (20 dB).

Two tone operation

To generate two tones, continue as follows:-

(12) Press TONES (15) to display the TONES STANDARD MENU. Press the MODE key (2) which is arrowed by TWO TONES to display the TWO TONES menu.

(13) Press SEND TONE and then return to TRANSMITTER TEST. 2T is shown in reverse video on the display and a 1 kHz tone in addition to the variable frequency output is connected to the AF GEN OUTPUT socket (12). The level is that set previously for the variable frequency.

(14) To return to single tone operation, press TONES (15) and then the key which is arrowed by TWO TONES. Press the key which is arrowed by STOP TONE and then return to TRANSMITTER TEST.

RF POWER METER

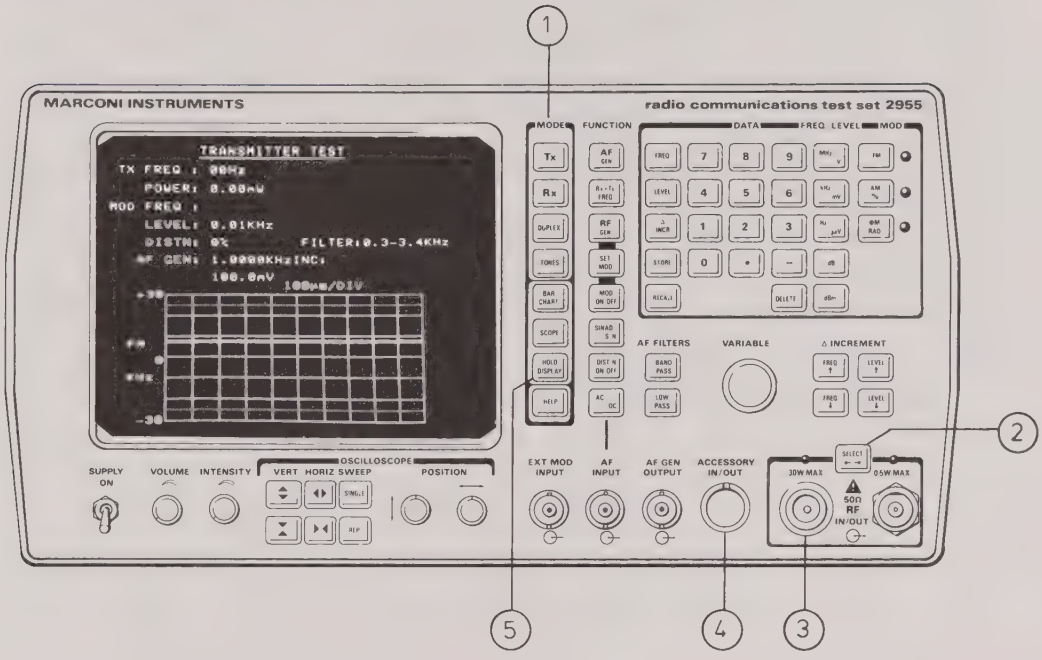


Fig. 3–4 RF power meter controls and connectors

(1) **TX key.** Connects the RF power meter and the RF counter to the RF IN/OUT N socket (3). Writes on the screen information concerning the instrument settings.

(2) **SELECT key and LEDs.** For selecting RF IN/OUT N socket (3). LED lights above the socket when it is correctly selected.

(3) **RF IN/OUT N socket.** For the transmitter output. A temperature sensor detects excessive power being applied. Impedance 50 Ω.

(4) **ACCESSORY socket.** DIN 7–pin connector for the external RF directional power head option.

(5) **HOLD DISPLAY key.** The display, including the oscilloscope or bar charts (but not the trace), is frozen. All keys, except HOLD DISPLAY, are inoperable. When the key is pressed again, the hold is released.

Power meter operation

(1) Select mode TX (1). This connects the RF power meter and the RF counter to the RF IN/OUT N socket (3). Writes TRANSMITTER TEST on the screen.

(2) Press SELECT (2), if necessary, to light the LED above the RF IN/OUT N socket (3).

(3) Connect the unit under test to the RF IN/OUT N socket (3) .

(4) The instrument automatically tunes to the transmitter's RF frequency.

(5) If the applied power exceeds that allowable, the display flashes 'REMOVE RF INPUT' followed shortly by an audible warning.

(6) The applied RF power and carrier frequency are displayed on the screen.

(7) If required, the transmitter may be tuned for minimum or zero indicated offset using the 2955 – see 'Transmitter frequency adjustment' under 'Applications'.

(8) If required, connect the RF directional power head to the ACCESSORY socket (4) for automatic measurement and display for forward and reverse power and of VSWR. (See the Power Head Manual for details.)

MODULATION METER

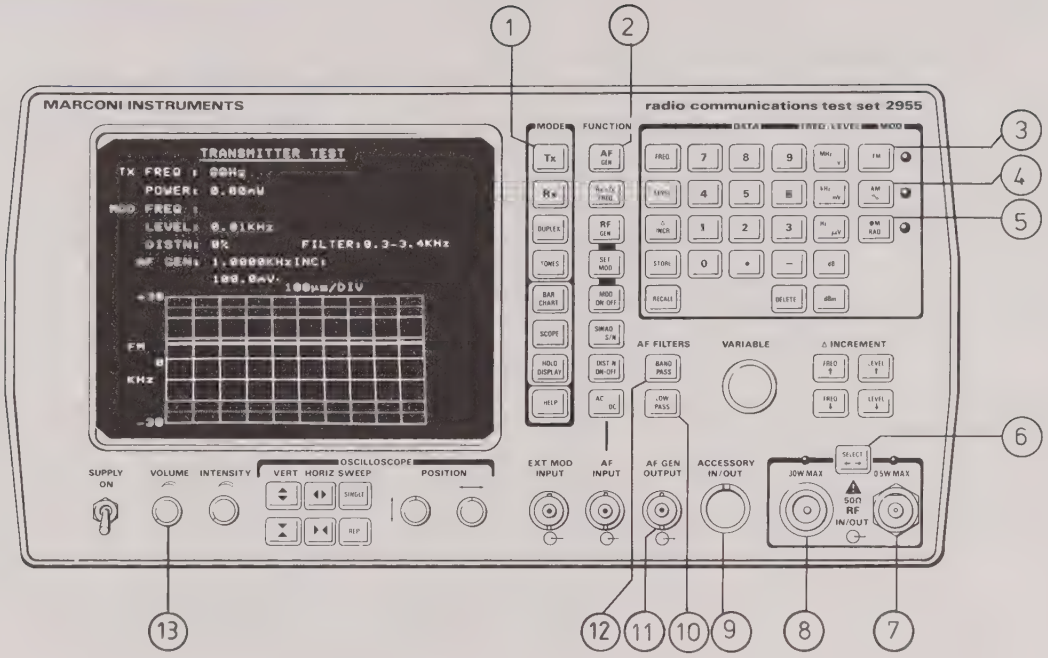


Fig. 3–5 Modulation meter controls and connectors

(1) **TX key.** Connects the modulation meter to RF IN/OUT socket (7) or (8) and connects the AF generator to the AF GEN OUTPUT socket (11). Writes on the screen information concerning instrument settings.

(2) **AF GEN key.** Enables the internal AF generator to supply a modulating signal to socket (11) .

(3) **MOD FM key and LED.** When the key is pressed, the LED lights to show that the FM route to the demodulator has been selected.

(4) **MOD AM key and LED.** When the key is pressed, the LED lights to show that the AM route to the demodulator has been selected.

(5) **MOD ΦM key and LED.** When the key is pressed, the LED lights to show that the ΦM route (FM route with de-emphasis) has been selected to the demodulator.

(6) **SELECT key and LEDs.** For selecting RF IN/OUT BNC or N socket (7) or (8). LED lights above the socket selected.

(7) **RF IN/OUT BNC socket.** For the telescopic aerial option. Automatically protected against excessive power.

(8) **RF IN/OUT N socket.** For high level inputs. A temperature sensor detects excessive power being applied. Impedance 50 Ω.

(9) **ACCESSORY socket.** DIN 7-pin connector for external loudspeaker or earphones. Connection does not disable the internal loudspeaker. Control of volume is by (13).

(10) **LOW PASS key.** Selects a 300 Hz or a 15 kHz low-pass filter.

(11) **AF GEN OUTPUT socket.** BNC connector supplying a modulating output in the range 20 Hz to 20 kHz. Impedance 5 Ω.

(12) **BAND PASS key.** Selects a 0.3 to 3.4 kHz band-pass filter.

(13) **VOLUME control.** Controls the volume of the internal loudspeaker and of a loudspeaker or earphones connected to (9).

Modulation meter operation

To measure AM depth or FM and DM deviation, proceed as follows:-

(1) Select TX (1). TRANSMITTER TEST is written on the screen.

(2) Connect the transmitter output to the RF IN/OUT N socket (8). Alternatively, connect the telescopic aerial option to the RF IN/OUT BNC socket (7).

(3) The instrument automatically tunes to the transmitter's frequency. If required, the transmitter may be tuned for minimum or zero indicated offset using the 2955 - see 'Transmitter frequency adjustment' under 'Applications'.

(4) Press SELECT (6) until the LED lights above the RF IN/OUT N connector (8) or the BNC connector (7).

(5) Select modulation type FM (3), AM (4), or ΦM (5). If greater than 50% AM is applied, there is a possibility that false readings may occur. Use keyboard tuning of the modulation meter as for 'Transmitter frequency adjustment'.

(6) Press BAND PASS (12) to select the 0.3 to 3.4 kHz BP filter or press LOW PASS (10) once or twice as necessary to select a 300 Hz or 15 kHz LP filter.

(7) If required, modulate the transmitter's carrier by connecting the AF GEN OUTPUT socket (11) to the microphone input of the transmitter. Set the frequency and level as under 'AF generator operation'.

(8) Read the displayed % depth for AM or the deviation and symmetry for FM and ΦM.

(9) Adjust VOLUME control (13) to monitor the demodulated signal using the internal loudspeaker, an external loudspeaker or earphones using the ACCESSORY socket (9).

(10) The demodulated output is available at the DE-MOD OUT socket on the rear panel.

DISTORTION METER (TX)

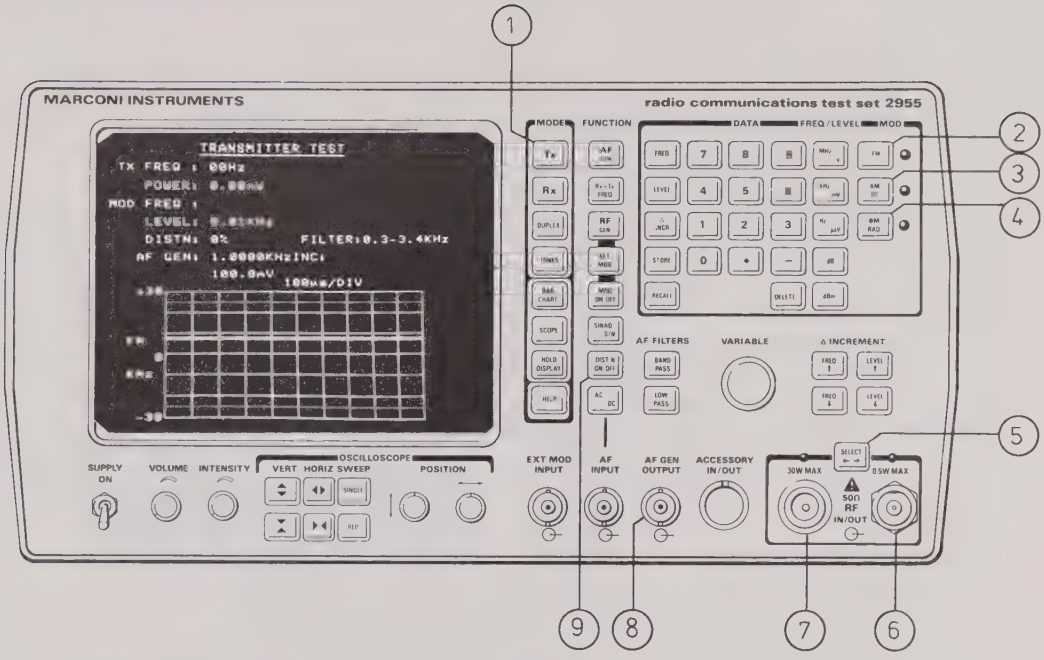


Fig. 3–6 Distortion meter (TX) controls and connectors

(1) **TX key.** Connects the distortion meter to the RF IN/OUT BNC socket (6) or N socket (7) and connects the AF generator to the AF GEN OUTPUT socket (8). Writes on the screen information concerning instrument settings.

(2) **MOD FM key and LED.** When the key is pressed, the LED lights to show that the FM route to the demodulator has been selected.

(3) **MOD AM key and LED.** When the key is pressed, the LED lights to show that the AM route to the demodulator has been selected.

(4) **MOD DM key and LED.** When the key is pressed, the LED lights to show that the ΦM route (FM route with the de-emphasis) has been selected to the demodulator.

(5) **SELECT key and LEDs.** For selecting RF IN/OUT socket (6) or (7). LED lights above the socket selected.

(6) **RF IN/OUT BNC socket.** For the transmitter input. Automatically protected against excessive power. Impedance 50 Ω.

(7) **RF IN/OUT N socket.** For the transmitter input. A temperature sensor detects excessive power being applied.

(8) **AF GEN OUTPUT socket.** Output used to modulate the transmitter under test with a 1 kHz tone. Impedance 5 Ω.

(9) **DIST'N ON-OFF key.** Causes the AF generator to generate a 1 kHz tone to socket (8). The display indicates when distortion is selected.

Distortion meter operation

To make a transmitter distortion measurement, proceed as follows:-

(1) Select TX (1). TRANSMITTER TEST is written on the screen.

(2) Connect the transmitter output to the RF IN/OUT BNC connector (6) for a low level RF output or to the RF IN/OUT N connector (7) for a high level RF output.

(3) Press SELECT (5) and ensure that the LED lights above the socket selected.

(4) The instrument automatically tunes to the transmitter's frequency. If required, the transmitter may be tuned for minimum or zero indicated offset using the 2955 - see 'Transmitter frequency adjustment'.

(5) Connect the AF GEN OUTPUT socket (8) to the transmitter's microphone input to provide amplitude, frequency or phase modulation.

(6) Press DIST'N ON-OFF (6) until DISTN is displayed. This causes a 1 kHz tone to be generated to socket (5) to modulate the transmitter.

(7) Select modulation FM (2), AM (3), or ΦM (4).

(8) Read the % distortion from the display.

APPLICATIONS

Transmitter frequency adjustment

If the transmitter setting, e.g. 400 MHz, does not agree with the measured frequency, e.g. 400.000100 MHz, the offset may be corrected as follows:-

(1) With TX mode selected, press FREQ and then enter the transmitter setting, e.g. 400 MHz.

(2) The offset is displayed as a positive or negative value, e.g. +100 Hz.

(3) Adjust the transmitter's internal frequency while observing the offset. Tune until negative values are seen and then readjust positively for zero offset.

(4) AUTO TUNE is written on the screen alongside the TX key. Press this key. The 2955 automatically tunes to and displays the transmitter's corrected frequency.

RECEIVER TESTING

RF GENERATOR

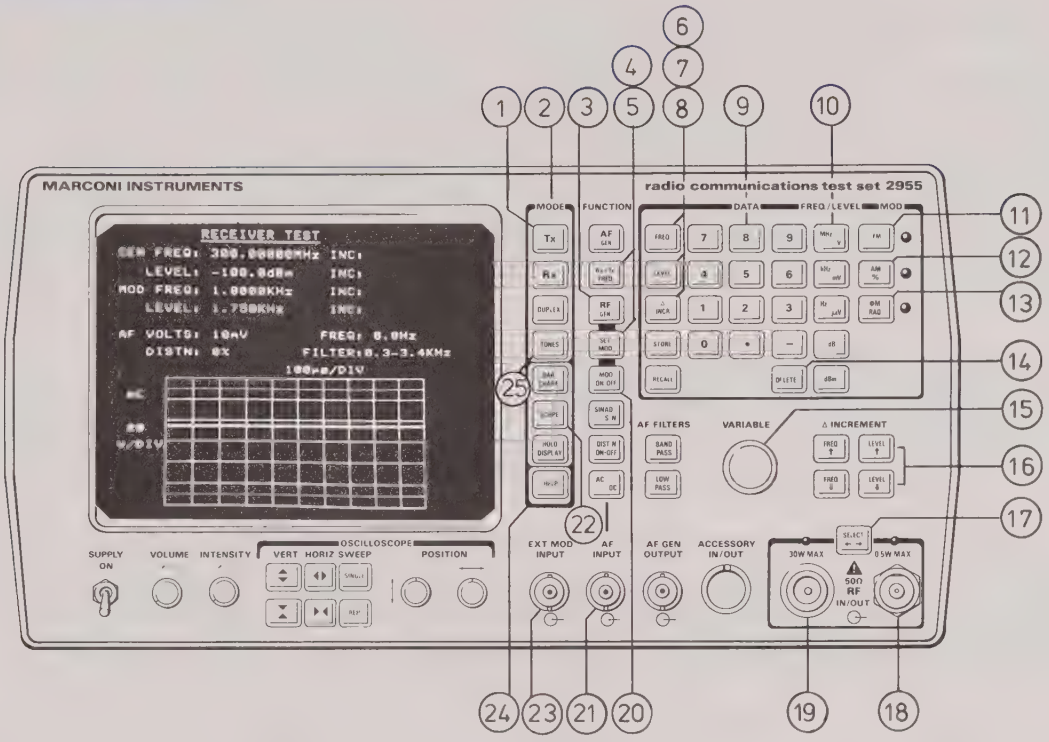


Fig. 3–7 RF generator controls and connectors

(1) **RX key.** Connects the RF generator to the RF IN/OUT BNC and N sockets (18) and (19). Writes on the screen information concerning the instrument settings.

(2) **MODE keys.** Used as soft keys to select programmed functions when menus are shown alongside on the screen.

(3) **RF GEN key.** Enables the internal signal generator.

(4) **RX=TX FREQ key.** Used only when in TX mode with the transmitter keyed up. Tunes the signal generator to the frequency of a transmitter connected to (18) or (19). The receiver section of a transceiver can be tested without having to enter the frequency.

(5) **SET MOD key.** Enables the internal signal generator modulation system. Followed by a FREQ (6) or LEVEL (7) entry to set the modulation value.

(6) **FREQ key.** Precedes a keypad (9) entry so that the entered data is recognized as a frequency.

(7) **LEVEL key.** Precedes a keypad (9) entry so that the entered data is recognized as a level. As supplied, each 2955 is programmed either for European or for North American standards. European practice is to show the output level as PD or EMF.

(8) **Δ INCR key.** Precedes a keypad (9) entry so that the entered data is recognized as an increment/decrement.

(9) **DATA keypad.** For data entry using numerals 0 to 9, decimal point and minus sign.

(10) **FREQ/LEVEL keys.** For defining units of frequency or level. Unless entering modulation, terminates the data entry.

(11) **MOD FM key and LED.** Enables the preceding frequency entry to be recognized as a frequency modulation deviation. Activates the frequency modulator for the signal generator. LED lights to show that FM has been selected. Modulation is switched on and off by (20).

(12) **MOD AM % key and LED.** Enables the preceding keypad (9) entry to be recognized as an amplitude modulation percentage. Activates the amplitude modulator for the signal generator. LED lights to show that AM has been selected. Modulation is switched on an off by (20).

(13) **MOD ΦM RAD key and LED.** Enables the preceding keypad (9) entry to be recognized as a phase modulation deviation. Activates the frequency modulator with pre-emphasis for the signal generator. LED lights to show that ΦM has been selected. Modulation is switched on and off by (20).

(14) **DELETE key.** Deletes a preceding digit, decimal point or minus sign entered on the keypad (9).

(15) **VARIABLE control.** Analogue control which varies the smallest increment of the function data. Step size is independent of (8) and depends upon range. The level for frequency assignment is shown in reverse field on the screen.

(16) **Δ INCREMENT keys.** Implement the increment (up arrow) key or decrement (down arrow) key in frequency or level in the step size set using (8).

(17) **SELECT key and LEDs.** For selecting RF IN/OUT socket (18) or (19). LED lights above the socket selected.

(18) **RF IN/OUT BNC socket.** For RF signal generator output levels up to 225 mV. Impedance 50 Ω. Automatically protected against excessive reverse power during duplex operation.

(19) **RF IN/OUT N socket.** For RF signal generator output levels up to 22.5 mV. Impedance 50 Ω.

(20) **MOD ON-OFF key.** Switches the signal generator modulation, both internal and external, on and off. Does not affect LEDs (11) to (13).

(21) **AF INPUT socket.** BNC socket used to set up an external modulation level.

(22) **SCOPE key.** When selected, the single trace oscilloscope display enables an external modulation level to be correctly set.

(23) **EXT MOD INPUT socket.** BNC connector for the application of an external modulating signal. When added to the internal modulation, provides two or three tone modulation. The maximum level is then displayed.

(24) **HELP key.** Enables access to the CHANGE PARAMETERS menu for selection of EMF (unloaded) or PD (loaded).

(25) **TONES key.** Used to select two tone modulation using the internal AF generator.

RF generator operation

Signal generator operation is detailed under frequency, level and modulation. Proceed as follows:-

(1) Select RX (1). RECEIVER TEST is written on the screen.

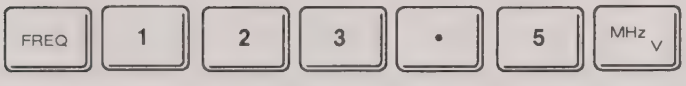
(2) Select function RF GEN (3).

(3) Connect the unit under test to RF IN/OUT BNC socket (18) or to N socket (19). Press SELECT (17) until the LED lights above the socket selected for the RF output.

Frequency

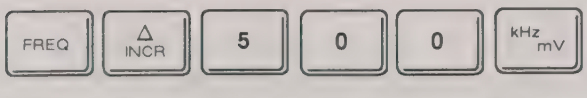
To tune the signal generator frequency, proceed as follows:-

(4) Select FREQ (6). The frequency to be changed is shown in reverse field. Enter the data on the keypad (9), ending with the frequency terminator (10). e.g. for 123.5 MHz, enter the following:-



If a mistake is made during data entry, press DELETE (14) and then enter the correct character. When, however, the terminator (10) has been pressed, re-enter the complete data. If incorrect data has been entered, e.g. a frequency outside the range of the instrument, the terminator is ignored and the entry is not be accepted. Use DELETE and then re-enter the data.

(5) If required, set the frequency increment/decrement by selecting Δ INCR (8) and enter the data, ending with the frequency terminator, e.g. for 500 kHz steps, enter the following:-



In the example, FREQ may be omitted since it has been previously entered in (4).

(6) Having set the step size, the frequency may be adjusted by repeatedly pressing one of the Δ INCREMENT keys (16), FREQ ↑ for an increment or FREQ ↓ for a decrement. For fine frequency control, use the VARIABLE control (15).

Level

To adjust the signal generator level, proceed as follows:-

(7) Select LEVEL (7). The level to be changed is displayed in reverse field. Enter the data on the keypad (9), ending with the level terminator (10), e.g. for -34 dBm, enter the following:-

(8) If required, set the level increment/decrement by selecting Δ INCR (8) and enter the data, ending with the level terminator, e.g. for 0.5 dB steps, enter the following:-

In the example, LEVEL may be omitted since it has been previously entered in (7).

(9) Having set the step size, the level may be adjusted by repeatedly pressing one of the Δ INCREMENT keys (16), FREQ ↑ for an increment or FREQ ↓ for a decrement. For fine level control, use the VARIABLE control (15).

To change between PD (loaded) and EMF (unloaded), press the HELP key (24) and then continue by following 'HELP Key Operation'.

Modulation

To set the signal generator modulation, proceed as follows:-

Modulation frequency

(10) Select SET MOD (5) .

(11) Select FREQ (6) and then enter the data, ending with the frequency terminator (10), e.g. for 1.5 kHz AM, FM or ΦM, enter the following:-

(12) If required, the modulation frequency may be adjusted as for (5) and (6).

Amplitude modulation

(13) For amplitude modulation, select LEVEL (7) and then enter the modulation depth in %. Terminate with key (12) and check that the associated lamp lights, e.g. for 60% AM, enter the following:-

(14) If required, set the modulation value increment/decrement by selecting Δ INCR (8) and entering the step size, e.g. for a 2% step, enter the following:-

In the example, LEVEL may be omitted since it has been previously entered in (13).

(15) Adjust the modulation value as for (9).

Phase modulation

(16) For phase modulation, select LEVEL (7) and then enter the deviation in radians. Terminate with key (12) and check that the associated lamp lights, e.g. for 6 radians, enter the following:-

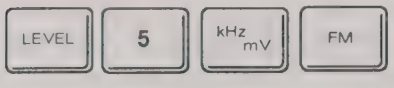
(17) If required, set the modulation value increment/decrement by selecting Δ INCR (8) and entering the step size, e.g. for a 2 radians step, enter the following:-

In the example, LEVEL may be omitted since it had been entered in (16).

(18) Adjust the modulation value as for (9).

Frequency modulation

(19) For frequency modulation, select LEVEL (7) and then enter the deviation, ending with the frequency terminator (10) . Press FM (11) and check that the associated lamp lights, e.g. for 5 kHz FM deviation, enter the following:-



(20) If required, set the modulation value increment/decrement by selecting Δ INCR (8) and entering the step size, e.g. for a 4 kHz step, enter the following:-

In the example, both LEVEL and FM may be omitted since they have been previously entered in (19).

(21) Adjust the modulation value as for (9).

Modulation on/off

(22) Switch the modulation (both internal and external, if applied) on or off as required using the MOD ON–OFF key (20). The off condition is shown in reverse field on the display.

External modulation (single or two tone)

(23) To set the external modulation, connect the signal to the AF INPUT socket (21). Select SCOPE (22) and observe the signal. Set the frequency and adjust the level in accordance with the data in the 'Modulation Section' of 'Performance Data', Chap. 1.

(24) Connect the modulating signal to EXT MOD INPUT (23). For two tone modulation, the external modulation then adds to the internal modulation. To switch off the internal modulation while retaining external modulation, enter 0 kHz for FM, 0% for AM or 0 radians for ΦM.

Internal two tone modulation

(25) Press TONES (25) to display the TONES STANDARD MENU. Press the MODE key (2) indicated by the SUB–AUDIBLE arrow. RX SUB–AUDIBLE TONE is displayed together with the current sub–audible tone frequency, level and modulation. As shown on the screen, the signal generator is now modulated by a fixed 1 kHz tone.

(26) Press the key arrowed by FREQUENCY and set the second, variable frequency using the keypad (9), ending with the frequency terminator (10).

(27) Press the key arrowed by MOD LEVEL and set the level using the keypad (9), ending with the level terminator (10).

(28) Press the key arrowed by SEND TONE to generate the sub–audible tone the return to RECEIVER TEST. SAT is displayed in reverse field against the 1 kHz modulation frequency.

(29) To return to single tone modulation, press TONES (25) and then the key arrowed by SUB–AUDIBLE. Press the key arrowed by STOP TONE and then return to RECEIVER TEST.

AF VOLTMETER

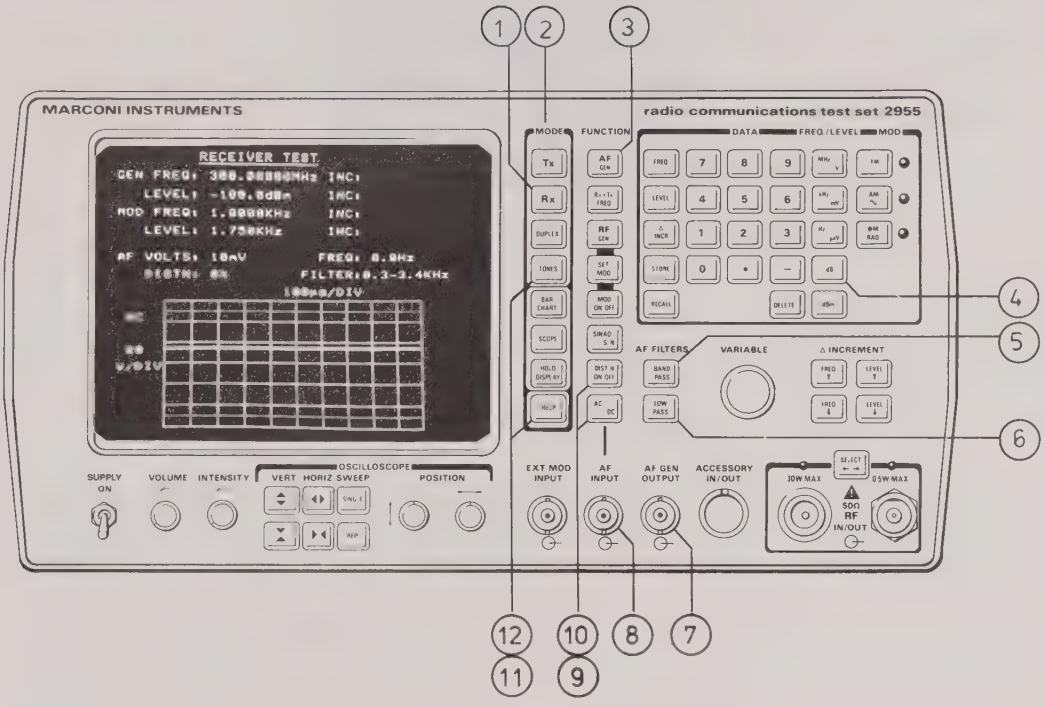


Fig. 3–8 AF voltmeter controls and connectors

(1) **RX key.** Connects the AF voltmeter to the AF input socket (8). Writes on the screen information concerning instrument settings.

(2) **MODE keys.** Used as soft keys to select programmed functions when menus are shown alongside on the screen.

(3) **AF GEN key.** Enables the AF generator.

(4) **dB key.** Selects dBV or dBr.

(5) **BAND PASS key.** Selects a 300 Hz to 3.4 kHz band–pass filter.

(6) **LOW PASS key.** Selects a 300 Hz or a 50 kHz low–pass filter.

(7) **AF GEN OUTPUT socket.** BNC socket for the optional 600 Ω dBm and 20 dB attenuator accessory – see 'Accessories', Chap. 1.

(8) **AF INPUT socket.** BNC socket for the AF or modulated DC input.

(9) **AC DC key.** Changes the state of the input from the socket (8) between an AF or a modulated DC voltage. The display indicates when AC or DC is selected.

(10) **DIST'N ON–OFF key.** Set to OFF for dBV or dBr measurement.

(11) **HELP key.** Used to select the 20 dB attenuator and 600 Ω dBm accessory as described under 'HELP Key Operation'.

(12) **TONES key.** Used to select two tone operation during AUDIO TEST.

AF voltmeter operation

(1) Connect the unit under test to the AF INPUT socket (8).

(2) Select mode RX (1). RECEIVER TEST is written on the screen.

(3) Press BAND PASS (5) to select the 300 Hz to 3.4 kHz BP filter or press LOW PASS (6) once or twice as necessary to select a 300 Hz or 50 kHz LP filter.

(4) To read AF volts, press the AC DC key (9) until AC is displayed.

(5) To read DC plus AF volts, press the AC DC key (9) until DC is displayed. The 50 kHz filter is automatically selected. Note that the DC is shown with no sign but may be positive or negative.

(6) To select dBV or dBr (dB relative to the entered level), set (10) to DIST'N OFF.

(7) If required, change between dBV and dBr by pressing the dB key (4).

(8) To use the optional 600 Ω dBm accessory, e.g. for testing telephone lines, connect this unit between the AF GEN OUTPUT (7) and the AF INPUT (8) sockets. Press the HELP key (11) and then continue by following 'HELP Key Operation'. When the accessory is selected, dBV or dBr changes to dBm.

Audio test

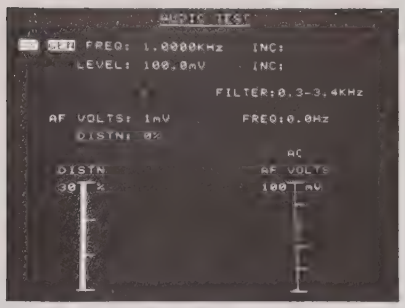
During AUDIO TEST operation, AF generator operation – normally a transmitter test function – is enabled in addition to the AF voltmeter. This permits the generator to be tuned while the voltmeter readings are noted. This may be used to plot the characteristics of a filter or an amplifier which is connected between the AF GEN OUTPUT and the AF INPUT sockets. To operate in AUDIO TEST, proceed as follows:–

(9) Press AF GEN (3). AUDIO TEST is written on the screen and the AF generator is enabled.

(10) Select the required filter as in (3).

(11) Select AC or DC as in (4) or (5).

(12) Select dBV or dBr as in (6) and (7).



(13) To use the 600 Ω dBm accessory, see (8).

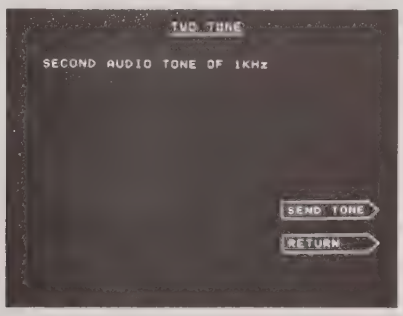
(14) To use the optional 20 dB attenuator, connect the unit to the AF GEN OUTPUT socket (7). Press the HELP key (11) and then continue by following 'HELP Key Operation'. When the accessory is selected, a reverse field A is displayed and the displayed AF generator level is decreased by a factor of 10 (20 dB).

Two tone operation may be selected during AUDIO TEST. A fixed 1 kHz tone is fed out with that from the AF generator to the AF GEN OUTPUT socket. Continue as follows:–

(15) To select two tone operation, press TONES (12). Generate two tones by pressing the key which is arrowed by SEND TONE. Return to AUDIO TEST. 2T is displayed in reverse field.

(16) To return to single tone operation, press TONES (12) and then switch off the 1 kHz output by pressing the key which is arrowed by STOP TONE. Return to AUDIO TEST.

(17) To return to RECEIVER TEST, press RX (1).



DISTORTION METER (RX)

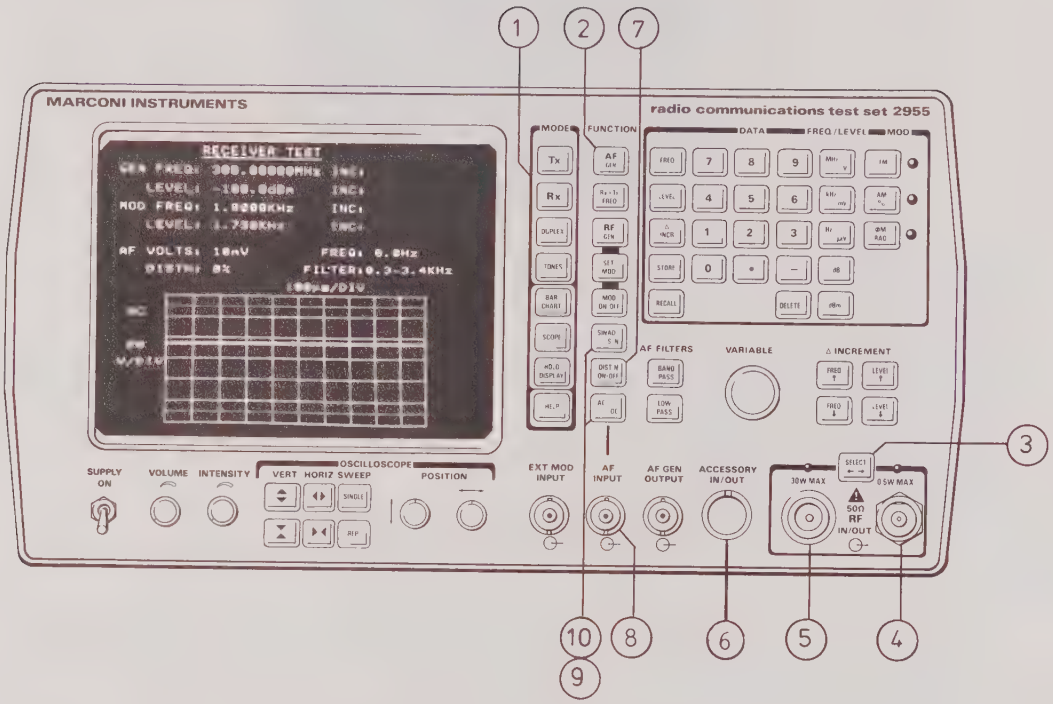


Fig. 3–9 Distortion meter (RX) controls and connectors

(1) **RX key.** Connects the signal generator output to RF IN/OUT BNC and N sockets (4) and (5) and connects the distortion meter to the AF INPUT socket (7). Writes on the screen information concerning instrument settings.

(2) **AF GEN key.** Enables the AF generator.

(3) **SELECT key and LEDs.** For selecting RF IN/OUT socket (4) or (5). LED lights above the socket selected.

(4) **RF IN/OUT BNC socket.** For RF signal generator output levels up to 225 mV. Impedance 50 Ω.

(5) **RF IN/OUT N socket.** For RF signal generator output levels up to 22.5 mV. Impedance 50 Ω.

(6) **ACCESSORY socket.** DIN 7-pin connector for an external psophometric (telephone weighting) CCITT or C-MESS filter option.

(7) **DIST'N ON-OFF key.** Causes the AF generator to modulate the signal generator with a 1 kHz tone.

(8) **AF INPUT socket.** BNC socket for the AF input.

(9) **AC DC key.** This key is disabled and AC automatically selected whenever DIST'N (5) or SINAD or S/N (9) is selected.

(10) **SINAD S/N key.** Selects SINAD or signal/noise and causes the AF generator to modulate the signal generator with a 1 kHz tone. The display indicates when SINAD or S/N is selected.

Distortion meter operation

To make a receiver distortion measurement, proceed as follows:–

(1) Select RX (1). RECEIVER TEST is written on the screen.

(2) Set the signal generator to the frequency of the receiver under test (see under 'Signal generator operation').

(3) Connect the receiver's aerial input to either the BNC socket (4) or the N socket (5).

(4) Connect the receiver's audio output to the AF INPUT socket (8).

(5) If required, select AF GEN (2). AUDIO TEST is written on the screen and the AF generator is enabled. See 'Audio test' below.

(6) Press the DIST'N ON/OFF key (7) until DISTN is displayed. AC coupling and the 0.3 to 3.4 kHz band–pass filter are automatically selected.

(7) Read the % distortion from the display.

(8) If required, connect an external psophometric filter to the ACCESSORY socket (6). Correct connection is denoted by the display showing either CCITT or C–MESS in place of any previously selected internal filter.

(9) Press the SINAD S/N key (10) until SINAD is displayed. AC coupling and the 0.3 to 3.4 kHz band–pass filter are automatically selected.

(10) Read the SINAD in dB from the display.

(11) Press the SINAD S/N key (10) until S/N is displayed.

(12) Read the S/N in dB from the display.

(13) To return to normal operation, select DIST'N OFF using key (7).

When AUDIO TEST is displayed, AF generator operation – normally a transmitter function – is enabled in addition to the receiver distortion meter. This enables the generator to supply the signal for distortion measurements, e.g. to test an audio amplifier which is connected between the AF GEN OUTPUT and the AF INPUT sockets.

Note ...

The SINAD S/N key (10) is inoperable during the audio test.

DUPLEX TESTING

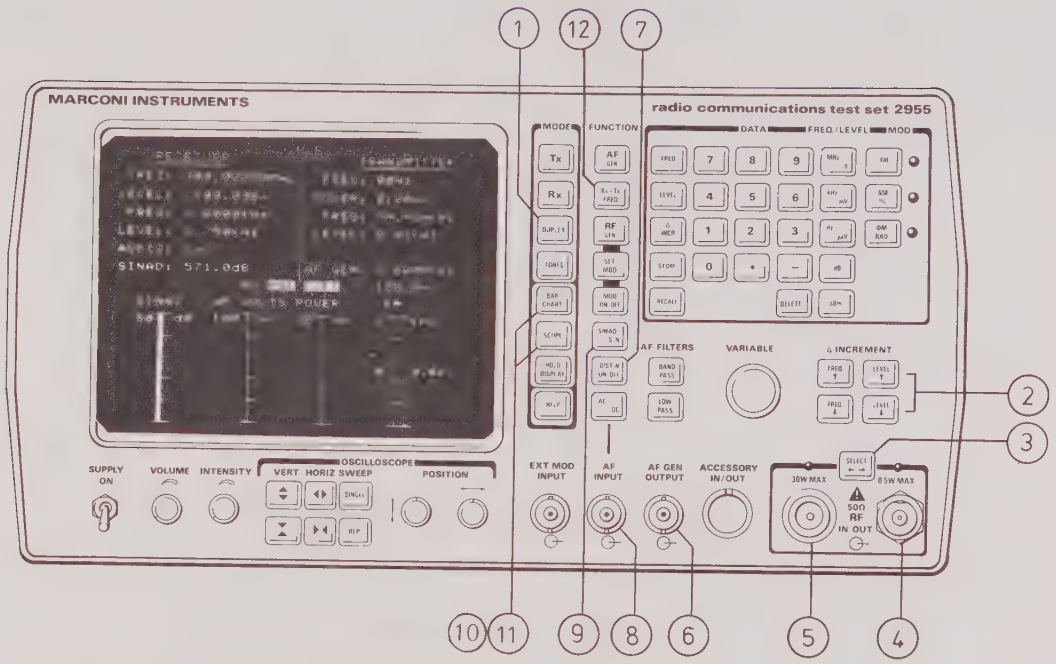


Fig. 3–10 Duplex operation controls and connectors

(1) **DUPLEX key.** Connects the RF generator to RF IN/OUT socket (4) or (5), the modulation meter and the power meter to socket (5) and the distortion meter to socket (8).

(2) **Δ INCREMENT keys.** Only operable when the RF generator step value has previously been set in the RX mode.

(3) **SELECT key.** Used to select one port or two port operation.

(4) **RF IN/OUT BNC socket.** Connects the RF generator to the receiver input for two port operation. Impedance 50 Ω.

(5) **RF IN/OUT N socket.** Connects the input from the transmitter for two port operation or simultaneous input from the transmitter and output from the RF generator for one port operation. A temperature sensor detects excessive power. Impedance 50 Ω.

(6) **AF GEN OUTPUT socket.** BNC output for modulating the transmitter in deviation measurements.

(7) **DIST'N ON–OFF key.** Causes the AF generator to modulate the RF generator with a 1 kHz tone.

(8) **AF INPUT socket.** BNC socket for the AF input for distortion or SINAD measurements.

(9) **SINAD S/N key.** Selects SINAD or signal/noise and causes the AF generator to modulate the signal generator with a 1 kHz tone. The display indicates when SINAD or S/N is selected.

(10) **SCOPE key.** Disabled as bar charts only are displayed in duplex mode.

(11) **BAR CHART key.** Disabled as bar charts are always displayed in duplex mode.

(12) **RX=TX FREQ key.** Can be used to set the RF generator to the transmitter frequency. When this key is used, it is followed by an increment key which has been preset to the appropriate offset.

Duplex operation

The following procedure assumes that both the transmitter and the receiver are modulated in the same way. If not, follow the procedures given under the appropriate transmitter and receiver test headings. Proceed as follows:-

(1) Press DUPLEX (1). DUPLEX is displayed together with the current instrument settings under RECEIVER and TRANSMITTER headings.

(2) Select one port operation by pressing the SELECT key (3) until ONE PORT is displayed in reverse field with the LED lit above socket (5).

(3) Select two port operation by pressing the SELECT key (3) until TWO PORT is displayed in reverse field with both LEDs lit. Additionally, BNC and N are displayed in reverse field to indicate that the connections are the receiver to BNC socket (4) and the transmitter to N socket (5).

(4) Set the receiver's frequency and set the signal generator frequency, level and modulation (as under these headings in 'Signal generator operation'). Note, however, that the Δ INCREMENT keys (2) are only operable when the signal generator step value had previously been set in RX mode. Note also that the maximum signal generator output level is -80 dBm for one port and -54 dBm for two port operation.

(5) Connect the receiver input to either the N socket (5) for one port operation or to the BNC socket (4) for two port operation.

(6) Set the transmitter's frequency, level and modulation.

(7) Connect the transmitter's output to the N socket (5) for both one and two port duplex operation.

(8) Read the transmitter's RF power and modulation parameters from the display. Note that, for duplex mode, the bar chart display is required and therefore both the SCOPE (10) and BAR CHART (11) keys are disabled. Note also that the audio filter value is displayed under the TX side of the display but applies to both TX and RX measurements.

(9) Connect the AF GEN OUTPUT socket (6) to the transmitter's microphone input.

(10) Connect the receiver's audio output to the AF INPUT socket (8).

(11) Press DIST'N ON (7), SINAD or S/N (9) and read the receiver's distortion, SINAD or signal/noise ratio from the display.

TONES DECODING AND ENCODING

TONES OPERATION

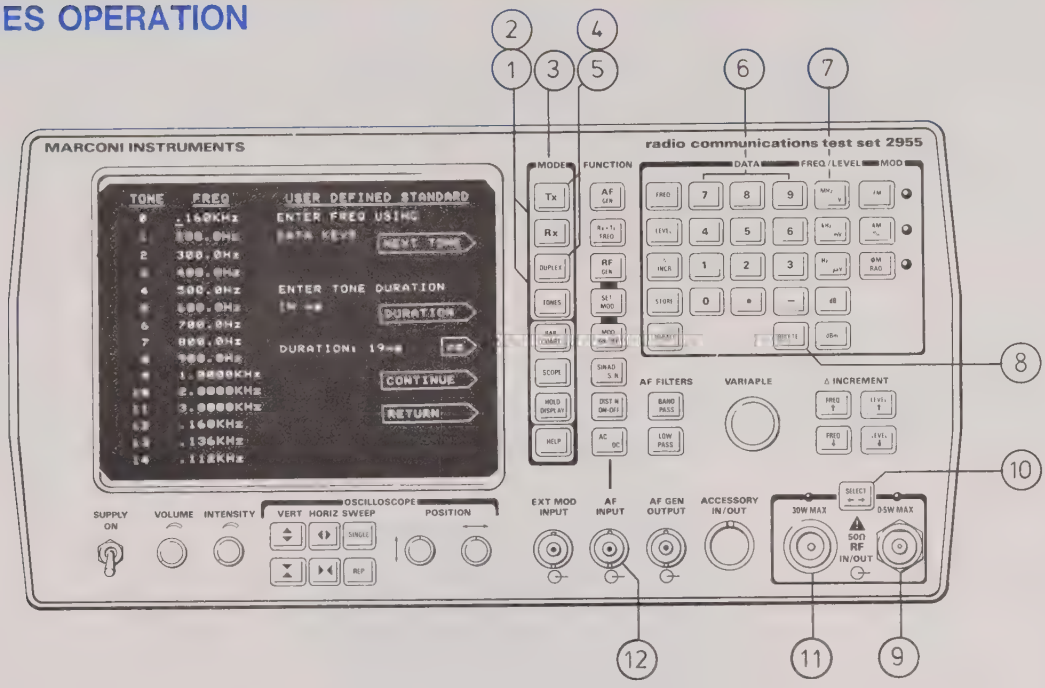


Fig. 3–11 Tones operation controls and connectors

(1) **TONES key.** Causes the TONES STANDARD MENU to be displayed. In duplex operation, causes the tones receiver test mode to be entered.

(2) **RX key.** Connects the RF generator output to RF IN/OUT sockets (9) and (11) and writes RECEIVER TEST on the screen.

(3) **MODE keys.** These are used as soft keys to select programmed functions from menus which are shown alonside on the screen.

(4) **TX key.** Connects the modulation meter to sockets (9) and (11) and writes TRANSMITTER TEST on the screen.

(5) **DUPLEX key.** Connects the RF generator and modulation meter to sockets (9) and (11).

(6) **DATA keypad.** For data entry using numerals 0 to 9, decimal point and minus sign.

(7) **FREQ/LEVEL keys.** For defining units for frequency or level. Terminates the data entry.

(8) **DELETE key.** Deletes a preceding digit, decimal point or minus sign entered on (6).

(9) **RF IN/OUT BNC socket.** For the RF generator output for two-port duplex operation. Impedance 50 Ω.

(10) **SELECT key and LEDs.** For selecting socket (11) for tones simplex operation. In duplex mode, selects one-port or two-port operation.

(11) **RF IN/OUT N socket.** For tones simplex or one-port duplex operation. A temperature sensor detects excessive power being applied. Impedance 50 Ω.

(12) **AF GEN OUTPUT socket.** BNC connector supplying an output in the range 20 Hz to 20 kHz for single tone modulation plus a fixed 1 kHz for two-tone modulation. Impedance 5 Ω.

Transmitter test

The tones receiver accepts up to 12 successive tones including inter-tone pauses. Frequency range is 300 Hz to 3.4 kHz, duration is 25 ms to 1.2 s and inter-tone pauses are up to 800 ms. To receive a programmed calling tone sequence, proceed as follows:-

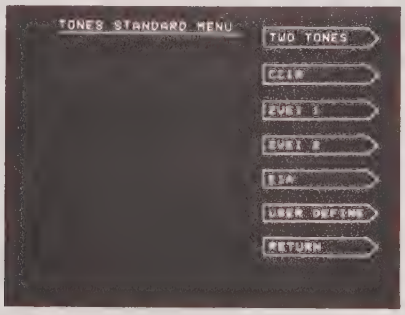
(1) Select TX (4). TRANSMITTER TEST is written on the screen.

(2) Connect the output from the transmitter to the N connector (11).

(3) Key up the transmitter and ensure that the instrument is correctly tuned to the transmitter's frequency.

(4) Select TONES (1) with the transmitter on. The TONES STANDARD MENU is displayed. This enables the selection of one of four tone frequency standards or of a user-defined standard or two-tone operation.

(5) If a return to the TRANSMITTER TEST display is required, press the MODE key (3) which is arrowed by RETURN.



Tone frequency standard

(6) Select the required tone frequency standard (as shown in Table 3-1) from the 4 offered on the display using the MODE key (3) which is arrowed by the frequency standard, e.g. CCIR.

(7) TX SEQUENTIAL TONE is displayed.

(8) Press the key arrowed by RESET. The READY prompt is displayed.

(9) On the transmitter, activate the tones which are to be measured. When triggered, the instrument displays ACTIVE.

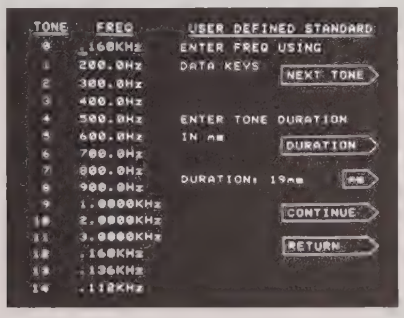
(10) At the end of each measurement, ACTIVE is removed and the received tone number, frequency and % error are displayed. If it is within 5% of a standard frequency, the closest tone number is displayed along with the associated error. If the error is worse than 2%, an asterisk is displayed next to the tone number.

(11) To return to TRANSMITTER TEST, press the key arrowed by RETURN.

(12) To select a user-defined standard, press the key arrowed by RETURN and then reselect TONES.

User-defined standard

(13) Define the standard by pressing the MODE key (3) which is arrowed by USER DEFINE. USER DEFINED STANDARD is displayed with the current tone numbers and frequencies.



(14) When a frequency change is required, press the key which is arrowed by NEXT TONE to step the flashing cursor to the required tone number under the frequency column.

(15) Enter the frequency using the keypad (6), ending with the frequency terminator (7). This moves the cursor down ready for the next entry.

(16) Complete the sequence by repeating (14) and (15) as necessary.

(17) Set the tones reception period by pressing the key which is arrowed by DURATION and then entering the duration in ms using the keys 0 to 9. Terminate by pressing the key which is arrowed by ms.

Table 3-1 TONE STANDARDS USED IN THE 2955

Tone number	CCIR	ZVEI	DZVEI	EIA*	EEA*
0	1981	2400	2200	600	1981
1	1124.6	1060.6	970	741	1124
2	1197	1160	1060.6	882.5	1197
3	1275	1270	1160	1023	1275
4	1358	1400	1270	1164	1358
5	1446	1530	1400	1305	1446
6	1540	1670	1530	1446	1540
7	1640	1830	1670	1587	1640
8	1747	2000	1830	1728	1747
9	1860	2200	2000	1869	1860
10	2400	2800	2400	459	1055
11	930	810	2600	1000	930
12	2247	970	885	1000	2247
13	991	885	825	1000	991
14	2110	2600	810	1000	2110
Duration	100 ms	70 ms	70 ms	33 ms	40 ms
Extended	700 ms	700 ms	700 ms	330 ms	400 ms

All frequencies are shown in Hz.

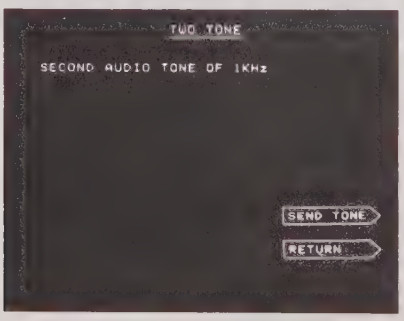
*As supplied, each 2955 is programmed either for EEA (European) or for EIA (North American). EEA or EIA is shown on the display.

(18) Press the key which is arrowed by CONTINUE to return to TX SEQUENTIAL TONE.

(19) Press the key which is arrowed by RETURN to return to TRANSMITTER TEST.

Two tone generation

(20) Select two tone operation by pressing the MODE key (3) which is arrowed by TWO TONES. The TWO TONE menu is displayed.



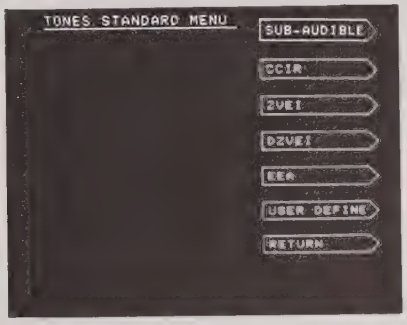
(21) Press SEND TONE and then return to TRANSMITTER TEST. 2T is shown in reverse video on the display and a 1 kHz tone in addition to the variable frequency output is connected to the AF GEN OUTPUT socket (12). The level is that set previously for the variable frequency.

(22) To return to single tone operation, press TONES (1) and then the key which is arrowed by TWO TONES. Press the key which is arrowed by STOP TONE and then return to TRANSMITTER TEST.

Receiver test

To generate a programmed calling tone sequence, proceed as follows:-

(1) Select RX (2). RECEIVER TEST is written on the screen.



(2) Connect the receiver input to either the BNC socket (8) or the N socket (11).

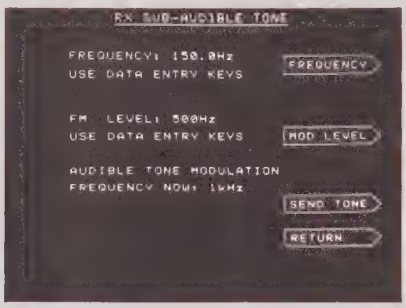
(3) Press SELECT (10) until the LED lights above the selected output socket.

(4) Select TONES (1). The TONES STANDARD MENU is displayed enabling the selection of one of four tone frequency standards or of a user-defined standard or of a sub-audible tone.

(5) When a return to RECEIVER TEST is required, press the MODE key (3) which is arrowed by RETURN.

Sub-audible tone

(6) Select a sub-audible tone by pressing the MODE key (3) which is arrowed by SUB-AUDIBLE. RX SUB-AUDIBLE TONE is displayed together with the current sub-audible tone frequency, level and modulation. As shown on the display, the internal signal generator is now modulated by a fixed 1 kHz tone.



(7) Press the key which is arrowed by FREQUENCY and set the second, variable frequency using the keypad (6), ending with the frequency terminator (7).

(8) Press the key which is arrowed by MOD LEVEL and set the level using the keypad (6), ending with the level terminator (7).

(9) Generate the sub-audible tone by pressing the key which is arrowed by SEND TONE. The SEND TONE arrow changes to STOP TONE to enable tone generation to be halted. When two-tone modulation is in operation, SAT is displayed in reverse video against the 1 kHz modulation frequency.

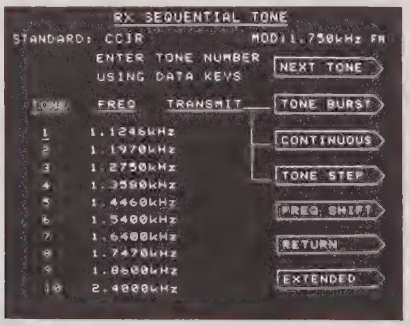
(10) To return to RECEIVER TEST, press the key which is arrowed by RETURN.

(11) To select either a tone frequency or a user-defined standard, press the key which is arrowed by RETURN and then reselect TONES.

Tone frequency standard

(12) Select the required tone frequency standard from the 4 offered on the display using the MODE key (3) which is arrowed by the frequency standard, e.g. CCIR.

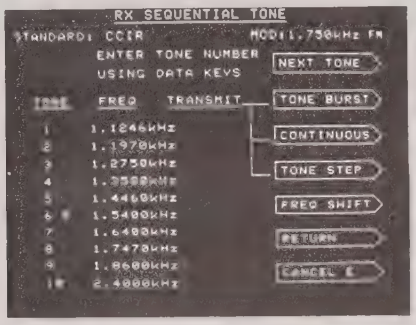
(13) RX SEQUENTIAL TONE is displayed with a flashing cursor under the TONE heading awaiting a tone number entry. Up to 11 of the tones in the chosen standard can be selected in the order required.



(14) Enter the tone number using the keypad (6) and press the key which is arrowed by NEXT TONE to terminate the entry. This causes the frequency to be displayed against the entered tone number and moves the cursor down ready for the next entry.

(15) To create an inter-tone pause, press the key which is arrowed by NEXT TONE without entering a tone number. Repeat for multiples of the tone duration. Then, when the next tone number is entered, NULLs are displayed. A pause may be created in place of an entered frequency by moving the cursor appropriately and then pressing DELETE (8).

(16) To select an extended tone (of 10 times the tone duration up to 700 ms unless user-defined) for the 5th from last tone, press the MODE key which is arrowed by EXTENDED. This facility is used for scanning receivers to ensure capture of the first tone. The letter E is displayed alongside the altered tone frequency. No response is made if less than 5 frequencies have been selected. The EXTENDED arrow changes to CANCEL E. Press this key to revert to normal tones operation.



(17) Complete the tone sequence by repeating (14) as necessary.

(18) Generate the tones sequences by pressing the key which is arrowed by TONE STEP, TONE BURST or CONTINUOUS as required. The CONTINUOUS arrow changes to STOP TONES to enable the continuous operation to be halted.

(19) If required, select a frequency offset in the range + and - 9% by pressing the key which is arrowed by FREQ SHIFT. Enter the offset using one of the keys 0 to 9 with a minus sign when appropriate. All the previously selected tone frequencies are reset and displayed.

(20) To return to RECEIVER TEST, press the key which is arrowed by RETURN. If CONTINUOUS has been selected, the tones continue to be transmitted.

(21) To select either a user-defined standard or a sub-audible tone, press the key which is arrowed by RETURN and then reselect TONES.

User-defined standard

(22) Define the standard by pressing the MODE key (3) which is arrowed by USER DEFINE. USER DEFINED STANDARD is displayed with the tone numbers and frequencies.

(23) Press the key which is arrowed by NEXT TONE to step the flashing cursor to the required tone number under the FREQ column.

(24) Any frequency between 20 Hz and 20 kHz can be assigned to any tone number between 0 and 14. Increment sizes for the tone frequencies are 0.1 Hz from 20 Hz to 3.2766 kHz and 1 Hz from 3.277 kHz to 20 kHz. Enter the frequency using the keypad (6), ending with the frequency terminator (7). This moves the cursor down ready for the next entry.

(25) Complete the sequence by repeating (23) and (24) as necessary.

(26) Set the tones generation period by pressing the key which is arrowed by DURATION and then entering the duration in ms using the keys 0 to 9. Terminate by pressing the key which is arrowed by ms.

(27) To select the required tone sequence, press the key which is arrowed by CONTINUE to return to RX SEQUENTIAL TONE.

Note ...

Extended tones are always 10 times the user-defined duration.

(28) To return to RECEIVER TEST, press the key which is arrowed by RETURN.

Note ...

This user-defined data is stored in non-volatile memory.

Duplex mode

To generate a programmed calling-tone sequence in duplex mode, proceed as follows:-

(1) Follow the instructions for interconnections and general operating procedures given under 'Duplex operation'.

(2) Continue from (4) of 'Receiver test'.

Note ...

Tones cannot be received in duplex mode. To test the reception of a calling tones sequence, leave duplex mode by following the instructions given under 'Transmitter test'.

HELP KEY OPERATION

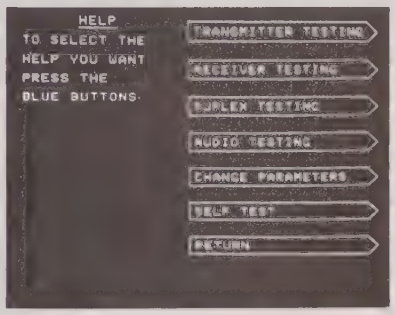
HELP KEY

When the HELP key is pressed, the HELP menu is displayed which enables you to obtain an operating summary, provides a choice of alternative parameters and implements the self test routines. To return to the operating mode press the key arrowed by RETURN.

Operating summaries

Pressing one of the MODE keys arrowed by the following provides an operating summary to enable you to implement the selected test.

TRANSMITTER TESTING
RECEIVER TESTING
DUPLEX TESTING
AUDIO TESTING

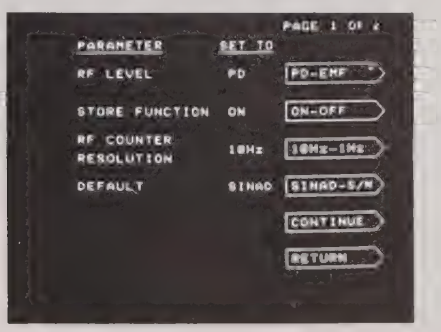


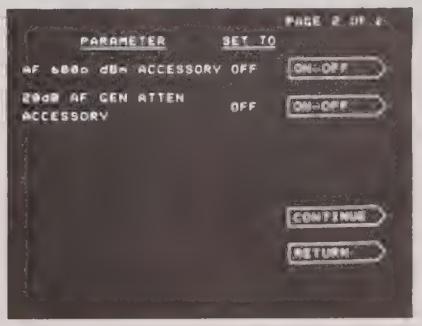
The HELP ON TESTING operating summary is then displayed – see Fig. 3-12. This includes information upon key operation, e.g. to select TRANSMITTER TEST the TX key must be pressed. But note that this is for information only; it is necessary to press the mode key arrowed by RETURN twice (once to return to the HELP menu and once to return to the operating mode) before pressing the designated key.

Where summaries occupy two pages, press the mode key arrowed by CONTINUE to change from one page to another. Return to the HELP menu by pressing the key arrowed by RETURN.

Alternative parameters

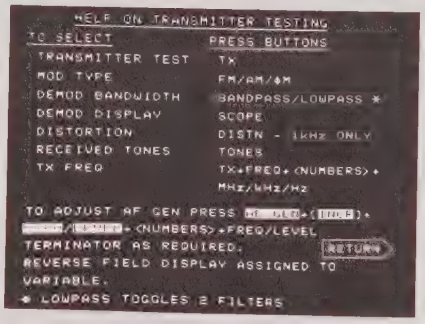
Pressing the MODE key arrowed by CHANGE PARAMETERS causes the PARAMETERS menu to be displayed. To change between the two menu pages, press CONTINUE. The arrowed keys all toggle between two states, the selected parameter being shown under the SET TO heading in the following display:–



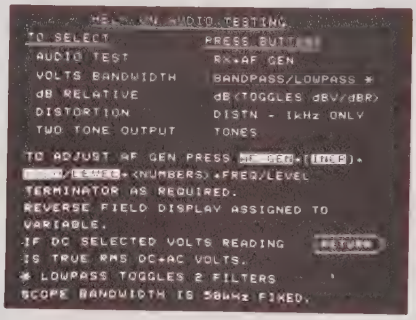


*The r.f. counter resolution will be set to 1 Hz providing the frequency is below 200 MHz.

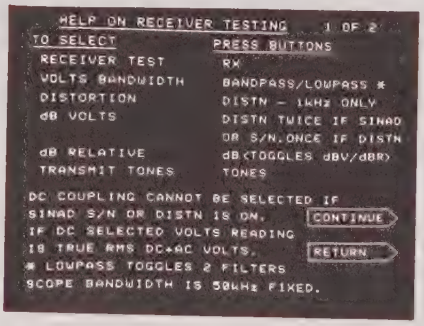
Return to the HELP menu by pressing the key arrowed by RETURN.

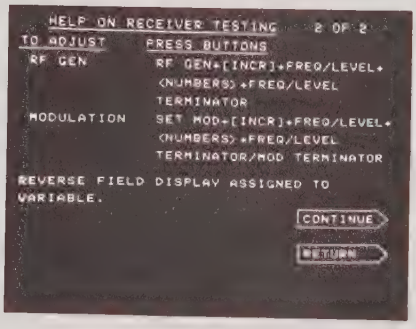


Transmitter testing

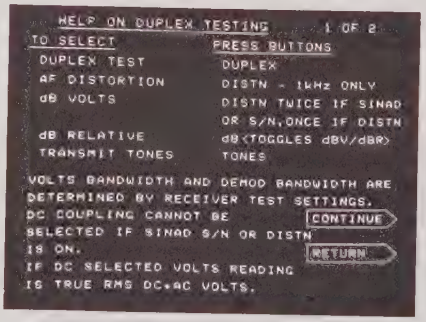


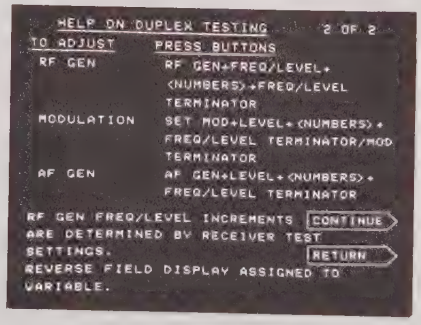
Audio testing





Receiver testing

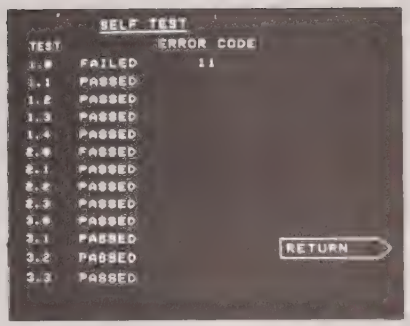




Duplex testing

Fig. 3-12 HELP ON TESTING operating summaries.

Self test



Pressing the MODE key arrowed by SELF TEST causes the instrument to implement the self test procedures. At the end of each of the thirteen tests either PASSED or FAILED appears against the test number. In the case of a failed test, the error code for the failure is shown. At any time, the self test may be terminated by pressing the key arrowed by RETURN. At the end of the tests the instrument waits for RETURN, which displays the HELP menu.

Note...

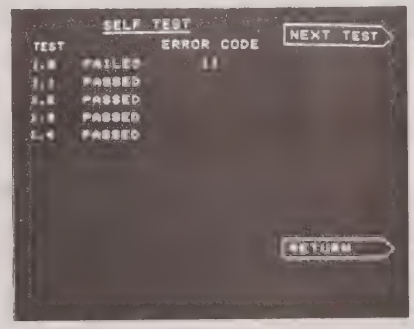
When using self test, remove any leads connected to the coaxial inlets and outlets in order to prevent the possibility of extraneous pick-up affecting the readings.

TEST ROUTINES

When a test fails during SELF TEST, it may be restarted as follows:-

When TEST FAILED appears during SELF TEST, the error code defining the source of error may be obtained as follows:–

(1) Press HELP then the key arrowed by CHANGE PARAMETERS. The CHANGE PARAMETERS menu is displayed.



(2) Press the TX key. The SELF TEST menu is displayed.

(3) Press the key arrowed by NEXT TEST to start the testing process. During each test, ACTIVE is displayed.

(4) When each test is completed, the test number is shown together with PASS or FAIL. If failure has occurred, the appropriate error code additionally appears. For the meaning of the code, refer to Tables 3-2a to -2c.

(5) To single step to the next test, press the key again (causing ACTIVE to reappear) or —to cause a sequence of tests—press the key repeatedly. Test numbers range from 1.0 to 3.3 in steps of 0.1. Selecting NEXT TEST following test 3.3 will restart the test sequence from 1.0.

TABLE 3-2a ERROR CODES FOR TEST 1: CHECK RF COUNTER AGAINST SIG. GEN. FREQUENCY

CODE (hex.)	
10	Test passed
11	FREQ 0* fails – HIGH FREQ (>50 Hz above set frequency)
12	FREQ 0 fails – LOW FREQ (>50 Hz below set frequency)
13	FREQ 1 fails – HIGH FREQ
14	FREQ 1 fails – LOW FREQ
15	FREQ 2 fails – HIGH FREQ
16	FREQ 2 fails – LOW FREQ
17	FREQ 3 fails – HIGH FREQ
18	FREQ 3 fails – LOW FREQ
19	FREQ 4 fails – HIGH FREQ
1A	FREQ 4 fails – LOW FREQ
1B	Frequency read fails

* FREQ 0 = 20 MHz (sig. gen. mixed range)
FREQ 1 = 111 MHz (sig. gen. divided range)
FREQ 2 = 218 MHz (sig. gen. oscillator 1)
FREQ 3 = 340 MHz (sig. gen. oscillator 2)
FREQ 4 = 480 MHz (sig. gen. oscillator 3)

TABLE 3-2b ERROR CODES FOR TEST 2: CHECK RF POWER METER AGAINST SIG. GEN.

CODE (hex.)	
20	Test passed
21	FREQ 0* fails – LOW POWER (>2 dB below set level)
22	FREQ 0 fails – HIGH POWER (>2 dB above set level)
23	FREQ 1 fails – LOW POWER
24	FREQ 1 fails – HIGH POWER
25	FREQ 2 fails – LOW POWER
26	FREQ 2 fails – HIGH POWER
27	FREQ 3 fails – LOW POWER
28	FREQ 3 fails – HIGH POWER

*	Sig. gen. setting	Power meter reading
FREQ 0 = 300 MHz	0.25 mW	79 mW
FREQ 1 = 849 MHz	0.25 mW	79 mW
FREQ 2 = 20 MHz	0.25 mW	79 mW
FREQ 3 = 20 MHz	0.125 mW	40 mW

Note...
The difference in setting and reading is due to 1 port duplex selection for the test.

TABLE 3-2c ERROR CODES FOR TEST 3: CHECK MODULATION FREQUENCY AND LEVEL

CODE (hex.)	
30	Test passed
	Test 3.0 – Mod. freq. 400 Hz, level 5 kHz
31	Mod. freq. fails*
33	Mod. level fails – low**
34	Mod. level fails – high
	Test 3.1 – Mod. freq. 1 kHz, level 5 kHz
32	Mod. freq. fails
35	Mod. level fails – low
36	Mod. level fails – high
	Test 3.2 – Mod. freq. 1 kHz, level 50%
37	Mod. level fails – low
38	Mod. level fails – high
	Test 3.3 – Mod. freq. 1 kHz, level 5 rads
39	Mod. level fails – low
3A	Mod. level fails – high

*Fails mod. freq. – Measured freq. more than 1 Hz away from setting.

**Fails mod. level – Measured mod. level more than 10% away from setting.

RF frequency set to 210 MHz.

GPIB OPERATION

GENERAL PURPOSE INTERFACE BUS (GPIB)

Functions

The GPIB* interface, offered as an optional accessory, allows the instrument to be coupled to a controller. The essential purpose of the GPIB functions is described below. Further information on the general features and applications of the GPIB system can be obtained from the separate GPIB Manual offered as an optional accessory (see Chap. 1, Accessories).

Setting the GPIB address

The instrument's talk and listen addresses can be selected on the rocker switch bank illustrated in Fig. 3-13. This is positioned on the GPIB unit to the right of the connector and is accessible at the rear panel. GPIB switch settings are summarized in Table 3-3.

Note...

If the address is changed, the instrument must be switched off then back on to enable the instrument to read the new GPIB address.

For talk and listen mode: Set switch 6 to 0 e.g. XXXXX0 where X = 0 or 1 to form an address in the range 0 to 30 decimal.

For talk only mode: Set switch 6 to 1 and switches 1 and 2 as required for the following:–

Switch 1	2	3	4	5	6	
0	0	X	X	X	1	Upper and lower case, <CR> suppressed.
0	1	X	X	X	1	Upper and lower case, <CR> not suppressed.
1	0	X	X	X	1	Upper case only, <CR> suppressed.
1	1	X	X	X	1	Upper case only, <CR> not suppressed.
				X =		Don't care.

Note...

If any switch position is changed, the instrument must be switched off and then back on to enable the instrument to read the new setting.

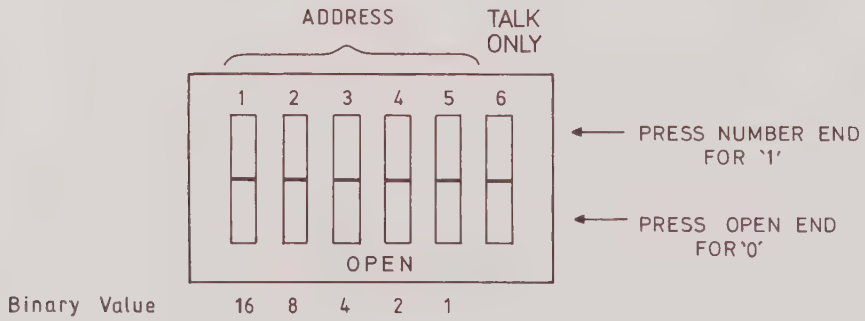


Fig. 3-13 GPIB address rocker switch bank

* *Where GPIB is Marconi Instruments implementation of the General Purpose Interface Bus in accordance with IEEE Standard 488-1978 and IEC Publication 625-1 (First Edition).*

TABLE 3-3 GPIB SWITCH SETTINGS

Switch	Bit	Function	
		Talker/Listener	Talk only
1	4	MS address bit	Upper case characters only (for machines with upper case only)
2	3	Address bit	Suppress carriage return in output (for dedicated printer units)
3	2	Address bit	Not used
4	1	Address bit	Not used
5	0	LS address bit	Not used
6	5	0 = talker/listener	1 = talk only

Capability identification codes

These are defined by IEEE Std. 488-1978. The capabilities are as follows:–

SH1: Source handshake (complete capability)
The source handshake sequences the transmission of each data byte from the instrument over the bus data lines. The sequence is initiated when the function becomes active, and the purpose of the function is to synchronize the rate at which bytes become available to the rate at which accepting devices on the bus can receive the data.

AH1: Acceptor handshake (complete capability)
The acceptor handshake sequences the reading of the data byte from the bus data lines.

T5: Talker function (complete capability)
The talker function provides the 2955 with the ability to send device dependent messages over the bus to other devices. The ability of any device to talk exists only when it has been designated as a talker by the controller.

TE0: Extended talker (no capability)
L4: Listener function (no listen only function)
The listener function provides a device with the ability to receive device dependent messages over the bus. The ability of any device to listen exists only when it has been designated as a listener by the controller.

LE0: Extended listener (no capability)
SR1: Service request function (complete capability)
The service request function gives the 2955 the capability to inform the controller when it requires attention.

RL1: Remote/local function (complete capability)
The remote/local function allows the 2955 to be controlled either by the local front panel keys or by device dependent messages over the bus.

PP0: Parallel poll function (no capability)
DC1: Device clear function (complete capability)
Device clear is a general reset and may be given to all devices in the system simultaneously (DCL). 2955 resets to the power-up mode.

DT1: Device trigger function (complete capability)
Device trigger is used by the 2955 to initiate a sequential tone sequence.

C0: Controller function (no capability)

E1: Open collector drivers
The GPIB drivers have open collector, rather than tri-state outputs.

Display annunciators

During GPIB operation, the following announcements are made on the screen:–

Remote: Once the instrument has received a remote enable and has been addressed, it will enter the remote state. This is annunciated by REM appearing in reverse field in the bottom right-hand corner of the screen.

Addressed: When in the remote condition and the instrument is addressed to either talk or listen, this is annunciated by ADR appearing in reverse field in the bottom right-hand corner of the screen.

Service request: When in the remote condition and enabled, a service request is raised, this is annunciated by SRQ appearing in reverse field in the bottom right-hand corner of the screen.

Local: When in the remote condition and Local Lockout (LLO) has not been sent, this is annunciated by LCL appearing next to the HELP key. Pressing HELP will then cause the instrument to enter a Go To Local (GTL) condition.

Note that the Go To Local condition is not the same as the power-on condition since the remote enable (REN) line from the controller will still be active.

GPIB commands

Commands take the form of a two-character alphabetic pair which may be followed by amplifying, non-exponential numeric data. Separators are required for multiple data and for multiple commands forming a string.

Command format

This takes the form of <HEADER> <DATA> <TERMINATOR/SEPARATOR>

<HEADER>	– A two-character command identifier.
<DATA>	– In form NR1 (integer) or NR2 (fixed decimal point), i.e. exponential formats are not allowed. Where there is more than one item of data, separators must be used.
<TERMINATOR/SEPARATOR>	– Used to delimit commands in command strings. Can be omitted if unambiguous.
<;> <,><CR>	– Command separators.
<LF> <ETX> <ETB> <EOI>	– Command string delimiters/terminators. Note that <EOI> must only be sent with the last character.
<SPACE>	– Ignored by the system–used for intelligibility only.

The example which follows shows the format of a command string where the data items are separated by commas, the commands are delimited by semicolons and the string is terminated by EOI:–

PO40,3 ; PO41,5 ; <EOI> – POke 3 and 5 to memory locations 40 and 41 respectively.

Notes...

(1) Certain commands cause the instrument to output more data than it can store in its output buffer, e.g. SV and RD39, see 'Non-keyboard commands' below. The result is that the data is held off from entering the buffer and hence the instrument stops.

To prevent locking up the instrument, a 2 second timeout takes effect. If data output has not been started, or is read out slower than 1 character per 2 seconds, then a buffer overflow error is raised and the instrument aborts the command.

(2) The input buffer length is 128 characters. If the buffer overflows, then the GPIB is held off until further space is available. If however, the buffer does not contain a command delimiter then the data is lost and an error is raised. This is because command interpretation, and hence buffer unloading, does not occur until a command string delimiter is received.

(3) If a syntax error is detected, then that command and all subsequent commands up to the next command separator are aborted and an error is raised.

(4) When Device Clear is used, it is recommended that a 0.5 s wait period follows while re-initialization of the instrument occurs. This avoids corruption or loss of GPIB commands.

Data output format

Every request for data will cause a response from the instrument. The form of the response will be that outlined below. Note that if no data is available the default response is NULL. Each reading will have its own terminator sequence but the <EOI> terminator is only sent once the output buffer is empty.

The format takes the form of <HEADER> <DATA FIELD> <TYPE FIELD> <TERMINATOR>

<HEADER> – Data is only sent in this field if a description is necessary, e.g. WHOLE PAGE.

<DATA FIELD> – This field contains the reading, it may be a numerical or alpha string. There is no fixed format except that numerical data will conform to NR1 or NR2 data types (i.e. non-integer).

<TYPE FIELD> – Data is only sent in this field if the data in the data field requires qualifying e.g. MHz, dBm, etc.

<TERMINATOR> – All readings are terminated with <CR> <LF>. This enables minimum interaction between a controller and a printer. Note that <ETX> <EOI> is sent when the output buffer is empty and ETX is selected.

Keyboard-equivalent commands

Below are listed the GPIB commands that perform the functions of the keys named alongside. Note however, that for the numeric, minus sign and decimal point keys, the normal ASCII equivalents are used. The commands are summarized in Fig. 3-14.

Command	Key	Function
TX	TX	Transmitter mode
RX	RX	Receiver mode
DX	DX	Duplex mode
TN	TONES	Tones mode
BC	BAR CHART	Bar chart
SC	SCOPE	Oscilloscope (if requested in duplex then the lower half of the screen is cleared and the bar charts are disabled)
HDn	HOLD DISPLAY	Hold display [off,on : n=0,1]
HP	HELP	Help
AG	AF GEN	AF generator
RT	RX=TX FREQ	Set RX to TX frequency
RG	RF GEN	RF generator
SM	SET MOD	Set modulation
MDn	MOD ON/OFF	Modulation switch [off, on : n=0,1]
SNn	SINAD S/N DIST'N	Off, default (SINAD or S/N), non-default (SINAD or S/N), distortion [n=0,1,2,3]
AC	AC/DC	AC coupling
DC	AC/DC	DC coupling

Command	Key	Function
FR	FREQ	Frequency
LV	LEVEL	Level
DI	△ INCR	Increment/decrement
STnn	STORE	Store settings [nn=01 to 38]
RCnn	RECALL	Recall settings [nn=00 to 38]
MZ	MHz/V	Megahertz
KZ	kHz/mV	Kilohertz
HZ	Hz/μV	Hertz
VL	MHz/V	Volts
MV	kHz/mV	Millivolts
UV	Hz/μV	Microvolts
DB	dB	Decibels
DM	dBm	Decibels relative to 1 mW
FM	FM	Frequency modulation
AM	AM%	Amplitude modulation
PM	øM RAD	Phase modulation
FIn	BAND PASS	BP filter [300 Hz–3.4 kHz : n=0]
FIn	LOW PASS	LP filter [15/50 kHz, 300 Hz : n=1,2]
FU	FREQ ↑	Frequency increment
FD	FREQ ↓	Frequency decrement
LU	LEVEL ↑	Level increment
LD	LEVEL ↓	Level decrement
SW	SINGLE	Scope single sweep and arm
RP	REP	Scope repetitive sweep
VD		Scope vertical scale increment
VU		Scope vertical scale decrement
TD		Scope horizontal timebase increment
TU		Scope horizontal timebase decrement
IPn	SELECT	Input socket select [BNC, N-type, one port duplex: n=0,1,2]
XA	TX	Soft key A
XB	RX	Soft key B
XC	DX	Soft key C
XD	TONES	Soft key D
XE	BAR CHART	Soft key E
XF	SCOPE	Soft key F
XG	HOLD	Soft key G

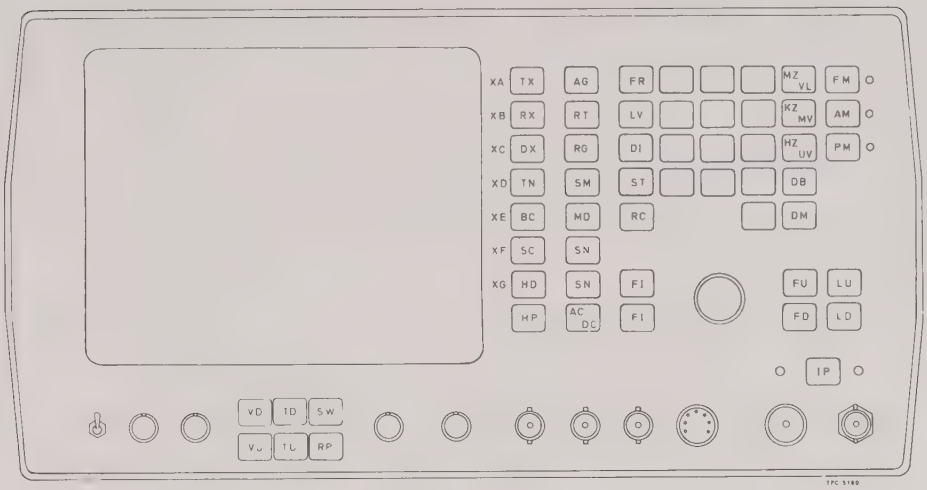


Fig. 3-14 Keyboard equivalent commands used in GPIB operation.

Non-keyboard commands

Below are listed the GPIB commands that provide functions additional to those for the keyboard.

SETTINGS

Command	Function
PD	Set instrument into potential difference mode.
EM	Set instrument into e.m.f. mode.
EV	Enable VARIABLE control
DV	Disable VARIABLE control
SE	Store/poke enable.
SD	Store/poke disable.
SQn	Service request [inhibit, error only, enable: n=0,1,2]
UC	Upper case only in terminator strings, e.g. DBM.
LC	Mixed case terminator strings, e.g. dBm.
WRc,r, <CSD>	Write data following command until a recognized delimiter is seen, e.g. EOI, ETX, <LF>. Start location on screen is c = column, r = row. Note that <CR> has the effect of <CR><LF>. Details on the use of this command are found under 'WR (WRite) command' later on in this chapter.

The ASCII values of screen characters are:–

ASCII (decimal)	Function
0,1	Graphics characters
2	Reverse field '0'
*3	EXT <CSD>
4-9	Reverse field '1' to '6'
*10	Linefeed
11,12	Reverse field '8' and '9'
*13	Carriage return
14-18	Graphics characters

ASCII (decimal)	Function
19	Reverse field '7'
20	'$'
21	'#'
22	Bell character
23	Graphics character (unused)
24	'?'
25	'@'
26	Copyright symbol
27	Graphics character (unused)
28	'('
29	'['
30	']'
31	Reverse field space
*32	Space
33	's'
34	'z'
35	Underline
36	'μ'
*37	'%'
38	'Ω'
39	'm'
40	'd'
41	'k'
42	'ø'
*43	'+'
*44	','
*45	'–'
*46	'.'
*47	'/'
*48-57	'0' to '9'
*58	':'
59	Reverse field top
60	Graphics character (unused)
61-64	Box characters
*65-90	'A' to 'Z'
91,92	Box characters
93	')'
94,95	Box characters
96	Pointer character
97-122	Reverse field 'A' to 'Z'
123-125	Graticule characters
126	Down arrow
127	Up arrow
128	Graphics character (unused)
129-191	Scope graticule characters
192	Flashing graphics character
193-218	Flashing 'A' to 'Z'
219-223	Flashing graphics characters
224-255	Dim bar chart characters

*Denotes standard ASCII characters.

Command	Function
DS	Disable screen output
ES	Enable screen output
CS	Clear screen
RS	Restore screen

Details on the use of these commands are given under 'Screen commands' later on in this chapter.

PG	Purges output buffer. Clears data available flag but SRQ remains raised.
POm,n	Pokes data n into location m. Note that this command includes a 10 ms delay for EEPROMs. Data cannot be poked to the display since it is not memory mapped (use the WR command).
DUm,n, n	As for PO but continues storing bytes until a terminator is received or a maximum of 64 bytes. Note that this command includes a 10 ms delay for EEPROMs.
TF	Tells instrument to record sequential tone frequencies.
TE	Tells instrument to record sequential tone numbers and errors.
LF	This causes the instrument to send <EOI> with <LF>. This is the default condition and will suit most controllers. However, care should be taken when there are multiple readings in the output buffer as data could be lost.
EX	This causes the instrument to send <EOI><ETX> when the output buffer is empty. <LF> is sent embedded between readings.
ET	Enable r.f. directional power head if fitted.
DT	Disable r.f. directional power head.
PR	Select peak envelope power for r.f. directional power head.
CR	Select CW power for r.f. directional power head.
SP	Suppress GPIB annunciators (cleared by RS).
BXn,m	Put up soft key boxes (used to arrow the mode keys). Where n = box pattern, m= length of box. Details on the use of this command are found under 'BX (BoX) command' later on in this chapter.
BP	Beep, sound a tone in the loudspeaker. Note that the loudness is determined by the VOLUME control setting.

READINGS

SV	When next addressed to talk, will send a data string which, when sent back to the instrument, will restore current settings see note (1) under 'Command format'.
PEm	When addressed to talk, will send data at location m. Note that variable areas only can be accessed.
RDn	When addressed to talk, will send reading or setting specified in n as follows:-

1	RF counter frequency	Reading
2	RF power	Reading
3	Modulation frequency	Reading
4	Modulation level	Reading
5	AF counter frequency	Reading
6	AF level	Reading
7	RX distortion; SINAD; S/N	Reading
8	TX distortion	Reading
9	Modulation peak; +ve deviation	Reading
10	Modulation trough; −ve deviation	Reading
11	RF forward power	Reading
12	RF reflected power	Reading

13	VSWR; return loss	Reading
14	Sequential tone 1	Reading
15	Sequential tone 2	Reading
16	Sequential tone 3	Reading
17	Sequential tone 4	Reading
18	Sequential tone 5	Reading
19	Sequential tone 6	Reading
20	Sequential tone 7	Reading
21	Sequential tone 8	Reading
22	Sequential tone 9	Reading
23	Sequential tone 10	Reading
24	Sequential tone 11	Reading
25	Sequential tone 12	Reading
26	Sequential tone standard	Setting
27	RF generator frequency	Setting
28	RF generator level	Setting
29	AF generator frequency	Setting
30	AF generator level	Setting
31	Modulation frequency	Setting
32	Modulation level	Setting
33	RF frequency increment	Setting
34	RF level increment	Setting
35	AF frequency increment	Setting
36	AF level increment	Setting
37	Mod frequency increment	Setting
38	Mod level increment	Setting
39	Whole page readings and settings (RX,TX and DX only)–see Note (1) under 'Command format' above).	

ER When next addressed to talk, will send the code for the last error detected.

VN When next addressed to talk, will send the software version number.

SK When next addressed to talk, will send an ASCII character corresponding to the last key pressed. The ASCII characters corresponding to the keys are shown in Fig. 3-15.

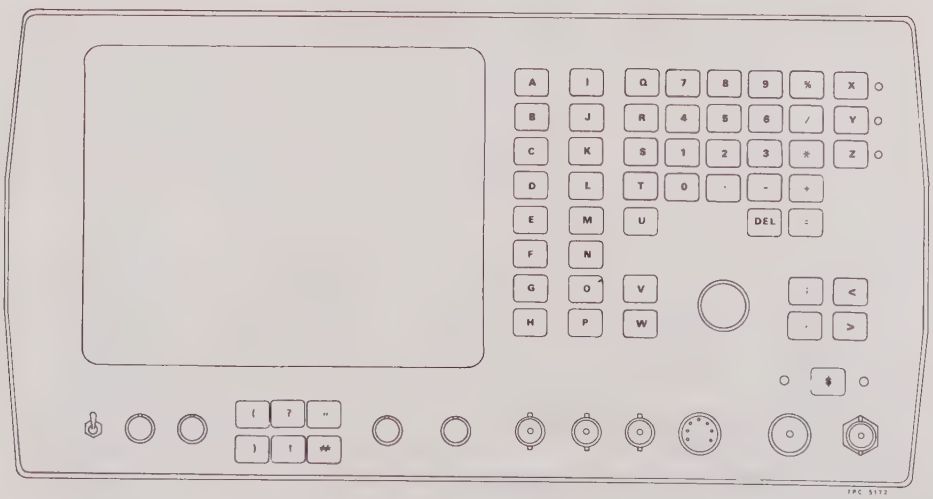


Fig. 3-15

ASCII characters sent (corresponding to last key pressed) when SK command is used in GPIB operation.

Operating example

Set the signal generator to 123.5 MHz (with increment/decrement step set to 100 kHz) at a level of −30 dBm modulated by 1.0 kHz a.m. at 50%, preparatory to measuring signal to noise ratio. The following string is sent after addressing the instrument as a listener:–

RX;RG;FR123.5MZ;DI100KZ;LV–30DM;SM;FR1KZ;LV50AM;MD1;AC;SN2<LF>

This breaks down as follows:–

RX	Receiver test
RG	RF generator
FR123.5MZ	Frequency 123.5 MHz
DI100KZ	Delta increment 100 kHz
LV–30DM	Level −30 dBm
SM	Set modulation
FR1KZ	Frequency 1 kHz
LV50AM	Level 50% a.m.
MD1	Modulation on
AC	AC coupled
SN2	Signal/noise

When ready, the level and distortion results can be selected for reading by sending the following:–

RD6<LF>RD7<LF>

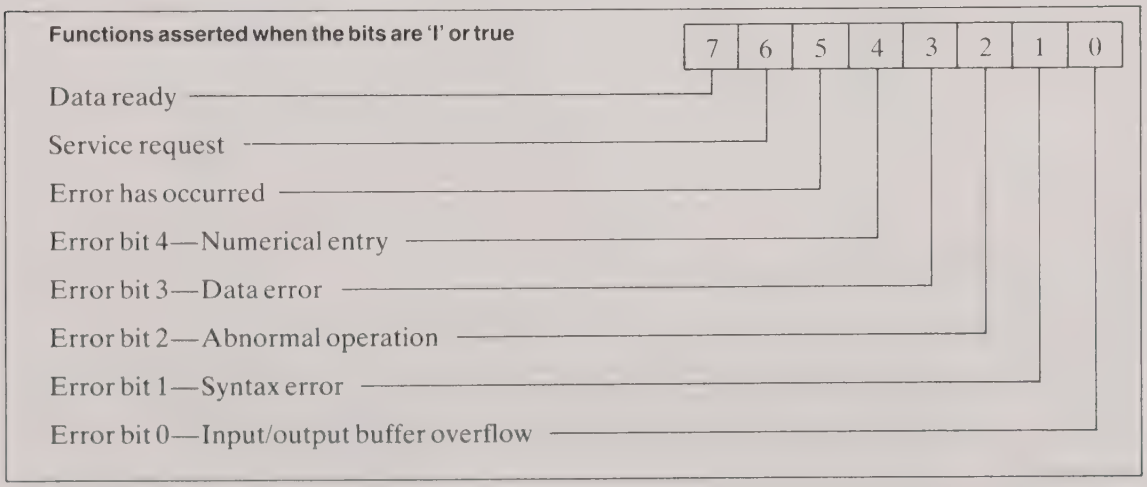
Then the instrument is addressed as a talker to receive the result.

Trigger

The bus trigger system can be used to start the transmission of a tone burst whilst the instrument is in the RX mode. However, the tone sequence must have been previously set up. Typical trigger commands include Selective Device Trigger (SDT) and Group Execute Trigger (GET).

Service requests (SRQ) and status byte

When enabled, the 2955 can request service to indicate to the controller that data is ready or to warn of an error condition. In response to a serial poll after asserting SRQ, the 2955 provides a status byte whose bits are allocated as shown in Fig. 3-15.



Notes...

(1) DATA READY and ERROR bits are cleared after the next time the instrument is addressed to talk.

(2) The SERVICE REQUEST bit is cleared after a serial poll.

CREATING A DISPLAY

The addition of the GPIB unit enables a display to be created to your own requirements. To make this as easy as possible, the instrument is programmed with a number of specialized screen commands as well as having a comprehensive character set stored in memory.

Screen commands

The operations involved in creating a display are: firstly to clear the current display; secondly to show the user-configured display with the selected measurements appearing when and where required; thirdly to return to measurement mode. The following commands are used for these purposes:–

CS—Clear Screen: This clears the screen but allows measurement results to be displayed.

DS—Disable Screen output: Stops measurements from being displayed on the screen.

ES—Enable Screen output: Enables measurement results to be written on the screen.

HD—Hold Display: Used to halt instrument operation.

RS—Restore Screen: Returns display to measurement mode.

The above commands may be used to operate the instrument in two modes: one in which the instrument is halted; and one in which the instrument is still running.

Instrument halted example:

COMMANDS	COMMENTS
"HD1CS" "WR——" "BX——" "SK——" ↓ "RS"	(1) Keyboard GPIB commands are ignored. (2) Readings held are those at time of "HD".

Instrument running example:

COMMANDS	COMMENTS
"CSDS" "ES,WR——"<LF>"DS" "ES,BX——DS" ↓ "RS"	(1) Keyboard GPIB commands are responded to. (2) New readings are valid and readable.

Printing on the screen

To print on the screen the BX and WR commands are used.

BX (BoX) command

This command is used to position and define the boxes (arrows) on the screen pointing to the mode keys. The command has the form BX n,m where n = box pattern and m = length of box. A display example is shown in Fig. 3-16.

Box pattern (n): The boxes appear in fixed positions on the screen against the 8 mode keys. These positions are binary coded—1 for a box, 0 for no box—and are binary weighted from top to bottom. For example, for boxes to appear next to the DUPLEX, BAR CHART and HOLD DISPLAY keys then n = binary 01010100, which (reading conventionally from right to left) = 84.

Length of box (m): This is the number of characters in the box to a maximum of 31. To produce the box to take 'PRESS WHEN READY' then m = 16 (spaces included). If boxes of different lengths are required, sequential BX commands must be sent.

Note...

The rightmost two squares are used for the point of the arrow and are not available for characters. Thus a box of length 6 to contain, e.g. RETURN will have an apparent length of 8.

To print a box of length 10 as shown in Fig. 3-16 but against the SCOPE key, the command string would be:–

"BX32,10"

To clear the screen prior to the boxes being printed, add 64 to m. For the example above m = 10 + 64 = 74.

Since CONTINUE and RETURN are commonly used for menu displays, the facility exists to call these labels up by simply adding fixed values to m. Note that the position of each arrow is fixed, i.e. CONTINUE against the SCOPE key, and RETURN against the HOLD DISPLAY key.

CONTINUE: To call up the CONTINUE label, add 32 to m. But ensure that there is sufficient room for the word in the box, i.e. m must be at least 32 + 8 = 40 otherwise CONTINUE will not be printed. Thus to display CONTINUE in a box of length 6 against the BAR CHART key, the command string would be "BX16,40".

RETURN: To call up the RETURN label against the HOLD DISPLAY key, add 128 to m. Ensure that m is at least 128 + 6 = 134 otherwise RETURN will not be printed. Fig. 16 shows an example of the use of this facility.

To print inside a box, other than for CONTINUE and RETURN which appear at fixed positions, use the WR command.

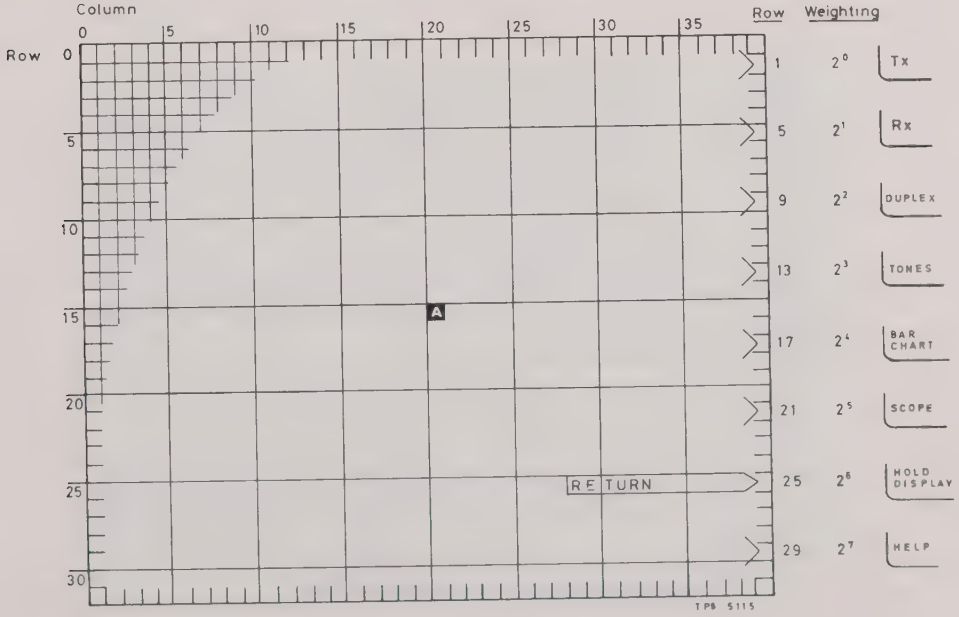


Fig. 3-16 Screen addressing example. Sending "WR20,15,a" will print the reverse field A positioned at the centre of the 40 x 32 display area. The arrowheads show the assigned positions of boxes. Sending BX64,138 will print RETURN as shown in a box of length 10 opposite the HOLD DISPLAY key.

WR (WRite) command

This command is used to write the data following the command until a delimiter is seen. The start location is c = column and r = row. For example, to print a reverse field A at the centre of the screen at column 20, row 15 as shown in Fig. 3-16 use:–

"WR20,15,";CHR$(97) or "WR20,15a"

Note that anything immediately following WRc,r is treated as a literal. Thus for multiple WR statements, end each one with <LF> or other terminator, e.g.

"WR20,15,a";CHR$(10)"WR20,16,b";CHR$(10) *not* "WR20,15,a,WR,20,16,b";CHR$(10)

The command is also used to print a label inside a box produced using the BX command. Refer to Fig. 3-16 to find the column (variable) and the row (fixed). For example, to print RETURN as shown in Fig. 3-16 but against the SCOPE key the command string would be:–

"WR28,21RETURN"

or inside a box:–

"BX32,10WR28,21RETURN"

Character set

The complete set of characters for the instrument is shown in Fig. 3-17. These characters may be used with the WR command to print onto the screen. Note that with the principal exception of the alphanumerics—A to Z, 0 to 9—the characters are not standard ASCII. Because of this, when a lower case letter is sent (in standard ASCII) from the controller it is interpreted by the 2955 as a reverse field upper case letter.

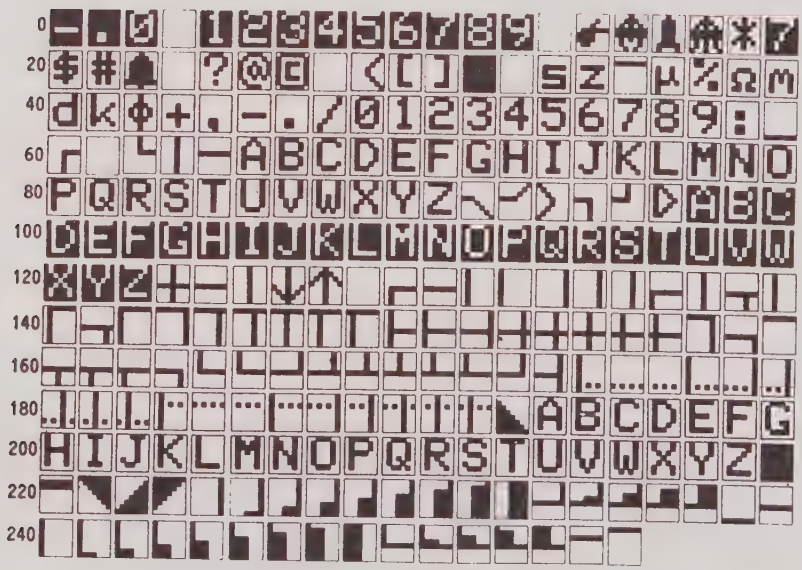


Fig. 3-17 Character set for 2955. Characters are written on the screen using the WR command. The characters shown blank are either unallocated or are machine functions, e.g. 32 is space. Note that character 10—reverse field 7—is not available. Use character 19 instead.

Reverse field characters

Many of the reverse field characters, by their structure, have an open top. For characters which have a bar at the top e.g. E,F,T this is particularly noticeable. A more pleasing appearance may be given to such a character by printing a reverse field top character (ASCII 59) directly above it. For example the reverse field E sent by:–

"WR10,15e"

is improved by adding:–

"WR20,14";CHR$(59)

Worksheet

Fig. 3-18 is provided as a worksheet for defining the screen addresses and plotting the screen layout.

Graticule characters

Some caution is required in the use of characters 128 to 191 since these are used to form the oscilloscope graticule. When the instrument recognizes a graticule character it also switches on the oscilloscope trace for the duration of that character. This may cause strange affects when these characters are used to form a user-defined display. Because of the method of triggering, no trace will be observed as long as these characters are not used in a vertical sequence (the screen is scanned from top to bottom). This means that, for instance, horizontal lines of these characters may be drawn as long as they are staggered i.e. chequerboard or alternate lines.

To detect the presence, or otherwise, of the trace in a user-defined display, check for any movement in the display while adjusting the oscilloscope POSITION controls.

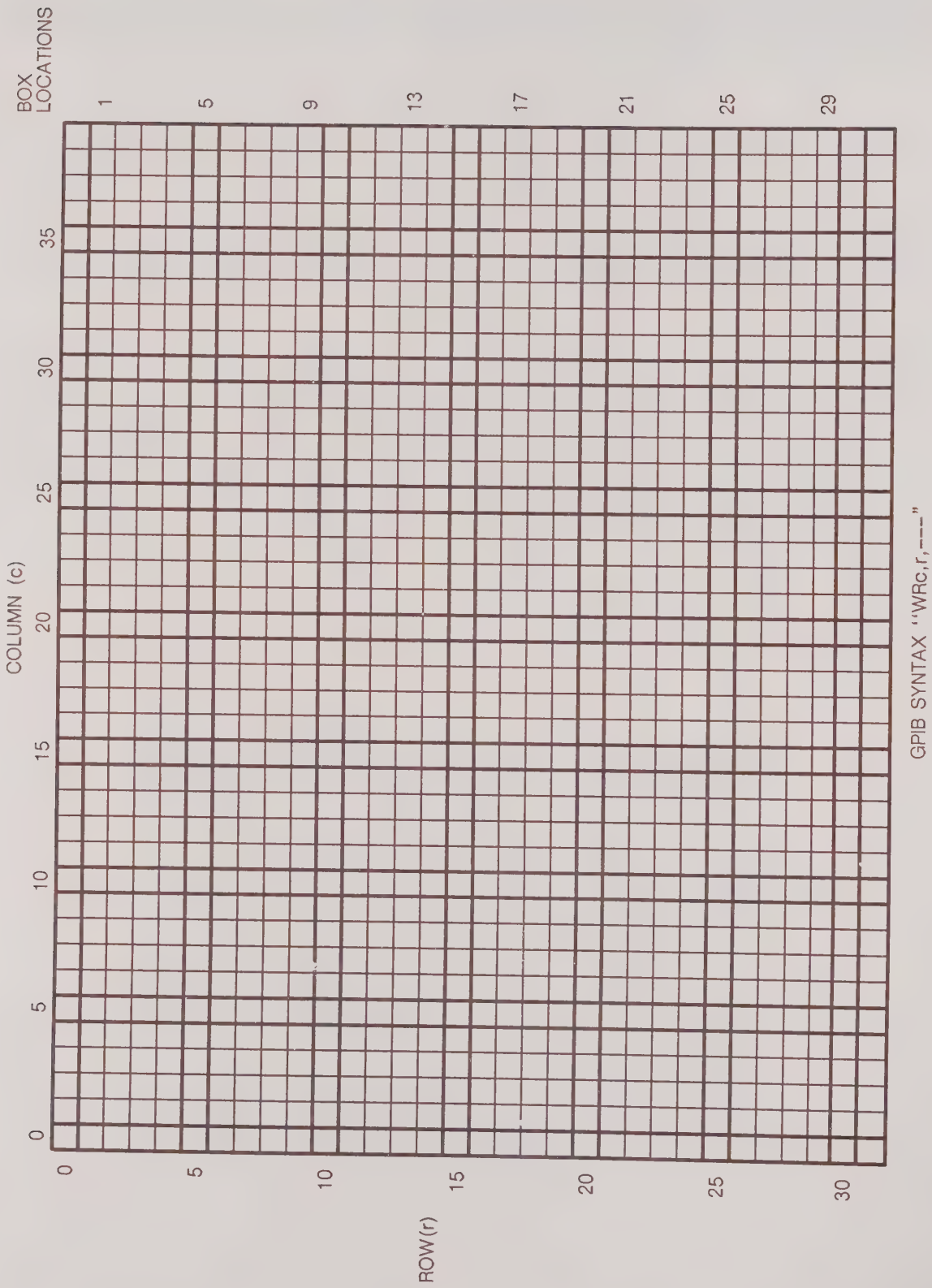
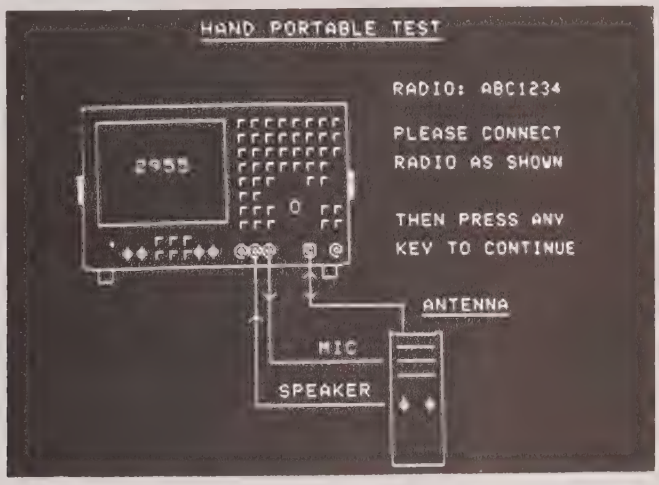


Fig. 3-18 Screen address worksheet

Display example

A typical application of a user-created display is shown in Fig. 3-19, which features an interconnection diagram. The accompanying program was written using an HP 9816 Personal Computer.




```
1000 Start:          DIM A$[100]
1010                 Addr=706
1020                 REMOTE Addr
1030                 RESTORE Radio
1040                 GOSUB Displaypage
1050                 STOP
1060 Radio:          DATA 11,0,HAND PORTABLE TEST
1070                 DATA 11,1,####################
1080                 DATA 0,4,"                              RADIO: ABC1234"
1090                 DATA 0,5,"  <@@@@@@@@@@@@@@@@@@@^"
1100                 DATA 0,6,"  ?<@@@@@@@@^<<<<<<<<<?"
1110                 DATA 0,7,"  ??         ?<<<<<<<<<?   PLEASE CONNECT"
1120                 DATA 0,8,"  ??         ?`\;;;;;;?"
1130                 DATA 0,9,"  ??  2955  ?<<<<<<<< ?   RADIO AS SHOWN"
1140                 DATA 0,10,"  ½?          ?<<<  << Ò"
1150                 DATA 0,11,"  ½?          ?<<       Ò"
1160                 DATA 0,12,"  ??          ?<<< O <<?"
1170                 DATA 0,13,"  ?>@@@@@@@@_<<<    <<?   THEN PRESS ANY"
1180                 DATA 0,14,"  ?     <<<             ?"
1190                 DATA 0,15,"  ?  **<<<**     ?   KEY TO CONTINUE"
1200                 DATA 0,16,"  >  ;;;;;;;;;;{{;;{   _"
1210                 DATA 0,17,"    >_          }}  >_"
1220                 DATA 0,18,"                }~  ~"
1230                 DATA 0,19,"                }}  >@@@@@@^ ANTENNA"
1240                 DATA 0,20,"                }          } #######"
1250                 DATA 0,21,"                }}         <`;;^"
1260                 DATA 0,22,"                }}   MIC  ?@@@?"
1270                 DATA 0,23,"                }>@@@@@@@@?@@@?"
1280                 DATA 0,24,"                }          ?@@@?"
1290                 DATA 0,25,"                } SPEAKER ?   ?"
1300                 DATA 0,26,"                >@@@@@@@@@?* *?"
1310                 DATA 0,27,"                           ?   ?"
1320                 DATA 0,28,"                           ?   ?"
1330                 DATA 0,29,"                           ?   ?"
1340                 DATA 0,30,"                           >@@@_"
1350                 DATA -10,0,0
1360                 !
1370                 !
1380                 !
1390 Displaypage:    OUTPUT Addr USING "K";"HD1ESCS"              ! CLEAR SCREEN
1400                 READ X,Y,A$
1410                 IF X<0 THEN RETURN                           ! PAGE COMPLETE?
1420                 OUTPUT Addr USING "K";"WR";X;",";Y;",";A$
1430                 GOTO 1400
1440                 !
1450                 !
1460                 !
1470                 END
```

Fig. 3-19 Display example—Interconnections

PRINTER

General

Any listen only printer may be used with the 2955. A printer designed for use with the instrument is offered as an optional accessory (see 'Accessories', Chap. 1).

Power supplies

When operating with the 2955, the printer offered as an optional accessory uses the ACCESSORY socket for its power supply. For stand-alone operation, it requires a supply of ±12 V at 2 A peak. If any other printer is used it would normally need to have its own power supply. However, the ACCESSORY socket may be used (pin 2 supplies ±12 V at approx. 100 mA continuous), but if so the low amount of power supplied must be taken into consideration.

GPIB cable

The GPIB cable is connected between the printer and the GPIB interface unit fitted at the rear of the 2955. For cables with the IEC connectors, the IEEE to IEC adapters (see 'Accessories', Chap. 1) may be used for conversion purposes.

Operation

For use as a ticket printer for printing out measurement results proceed as follows:–

(1) Make the power supply and GPIB cable connections as given earlier.

(2) Set TALK ONLY (switch 6 to 1) on the 2955 GPIB address switch. Set switches 1 and 2 respectively as follows:–

00 = Upper and lower case, <CR> suppressed
01 = Upper and lower case, <CR> not suppressed
10 = Upper case only, <CR> suppressed
11 = Upper case only, <CR> not suppressed

Note that in TALK ONLY mode, switches 3,4,5 are inoperative.

(3) Switch the 2955 off then back on to enable the instrument to read the new switch settings.

(4) Press the HOLD DISPLAY key. HOLD OFF is displayed against the SCOPE key and PRT appears against the HELP key.

(5) Press the key arrowed by PRT. This starts the printer and results in a printout of the major settings and readings shown in the top half of the display (see example in Fig. 3-20). Note that once printout has started there is no way to abort it.

(6) When using the ACCESSORY socket for power, the screen may be affected (sides drawn in) due to power drain, especially when printing rows of dots. This is unimportant and will not affect measurement results since these are already frozen.

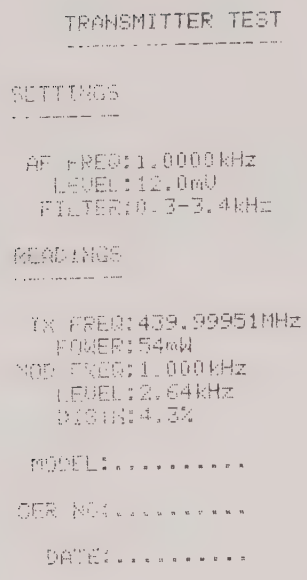


Fig. 3-20 Transmitter test printout example.

For additional printing information, refer to the appropriate printer instruction manual.

Chapter 4-1

BRIEF TECHNICAL DESCRIPTION

INTRODUCTION

This equipment comprises eleven instruments, most of which have some shared circuitry. Since the constructions of the counters and the oscilloscope are not relevant to the explanation of the operation of the instrument, and the tones encoder/decoder is mainly implemented in software, these are not described in this chapter. The signal generator, a.f. voltmeter, a.f. generator, r.f. power meter, modulation meter and distortion and SINAD meters are each described in outline with accompanying block diagrams.

SIGNAL GENERATOR

The signal generator simplified block diagram is shown in Fig. 4-1. Three voltage controlled oscillators phase locked to a 10 MHz reference operate with a synthesizer to provide outputs in the range 400 kHz to 1000 MHz. The generator may be amplitude, frequency or phase modulated, the modulating signal being derived from the a.f. generator. An audio signal applied to the EXT MOD INPUT socket adds to the internal modulating signal to provide a two tone modulation capability. Generator output frequency may be set to a maximum resolution of 50 Hz while the output level may be controlled in 0.1 dB steps. The HELP key is used to calibrate the output level in e.m.f. or p.d. Maximum output is 225 mV to the b.n.c. socket or 22.5 mV, via the 20 dB pad, to the N-type socket. Since these sockets are also used for r.f. power measurements, the signal generator is reverse power protected at the b.n.c. socket.

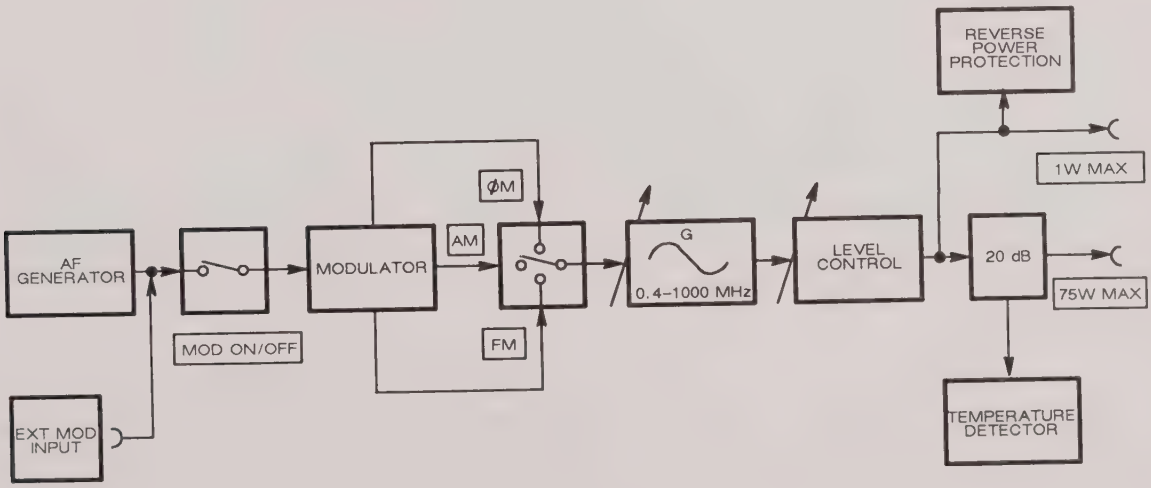


Fig. 4-1 Signal generator block diagram.

AF VOLTMETER

The a.f. voltmeter measures an input in the ranges 20 Hz to 20 kHz and 0 to 100 V applied to the AF INPUT socket. The AC/DC key is used to switch in and out a capacitor so as to measure a.f. volts with or without the d.c. component. Following processor-operated level control circuits and an output to the a.f. counter, the signal is fed through a switch-selected 0.3 to 3.4 kHz band-pass or a 300 Hz or 50 kHz low-pass filter. Output from an r.m.s. detector is analogue-to-digital converted before the measured level is displayed. The simplified block diagram is shown in Fig. 4-2.

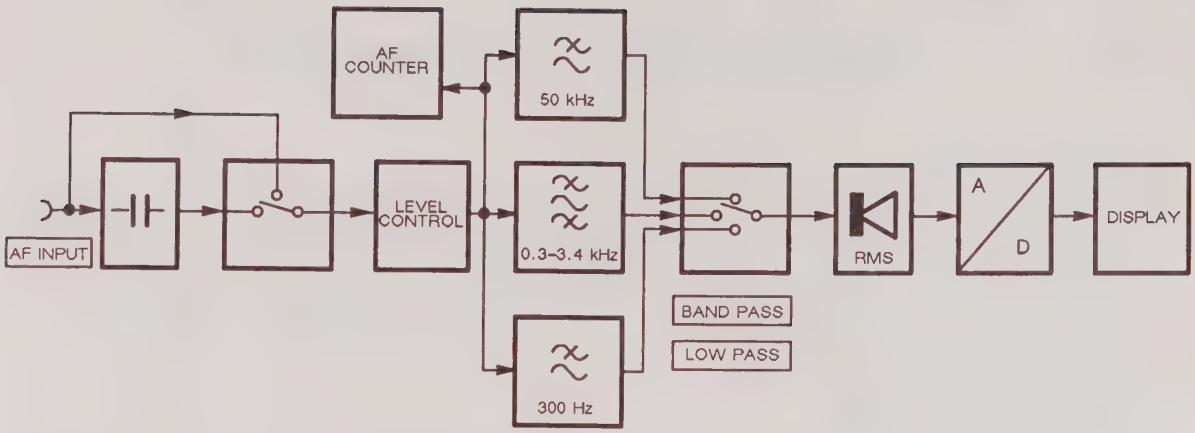


Fig. 4-2 AF voltmeter block diagram.

AF GENERATOR

The a.f. generator simplified block diagram is shown in Fig. 4-3. When enabled by the AF GEN key, the a.f. generator produces a variable frequency in the range 20 Hz to 20 kHz as well as a fixed 1 kHz used internally for distortion measurements. Maximum frequency accuracy is 0.01 Hz. Output may be controlled to a maximum e.m.f. level of 2.5 V at the AF GEN OUTPUT socket. The a.f. generator also provides the signal used to amplitude, frequency or phase modulate the internal signal generator.

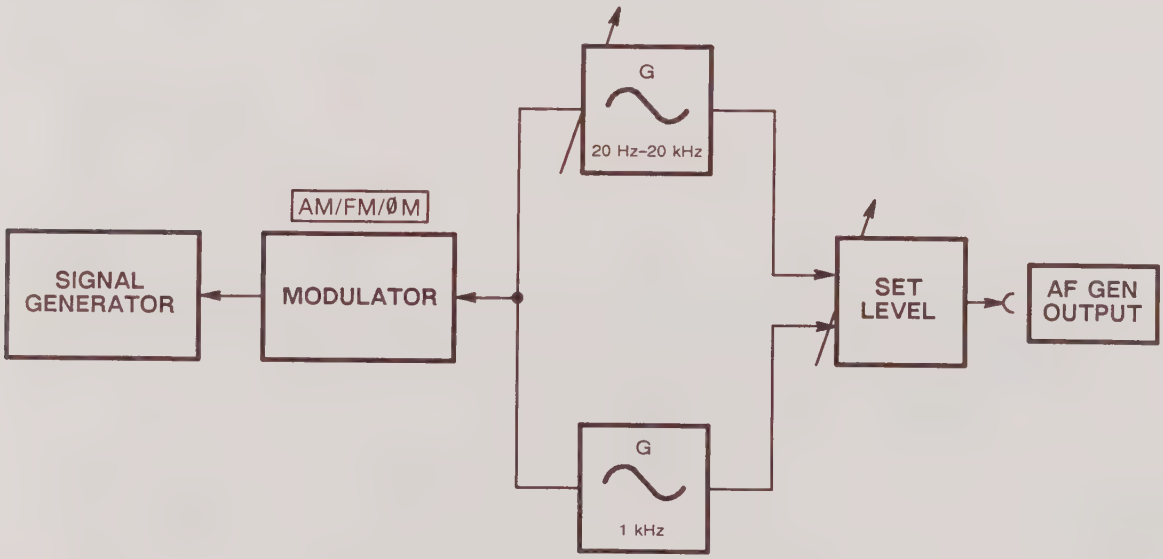


Fig. 4-3 AF generator block diagram.

RF POWER METER

The r.f. power meter simplified block diagram is shown in Fig. 4-4. Due to the 20 dB pad, continuous r.f. power of 30 W—or 100 W for a short period—may be applied to the N-type socket. Any overload detected by a heat sensor results in both visual and audible warnings to the user. Reduced accuracy measurements at low power from the b.n.c. socket may be made using the SELECT key. Following processor operated level control circuits an output is taken to the r.f. counter as well as to a sampling gate. The gate is switched at a sub-harmonic of the input frequency to produce a 110 kHz i.f. Output from an r.m.s. detector is analogue-to-digital converted and the r.f. power level displayed.

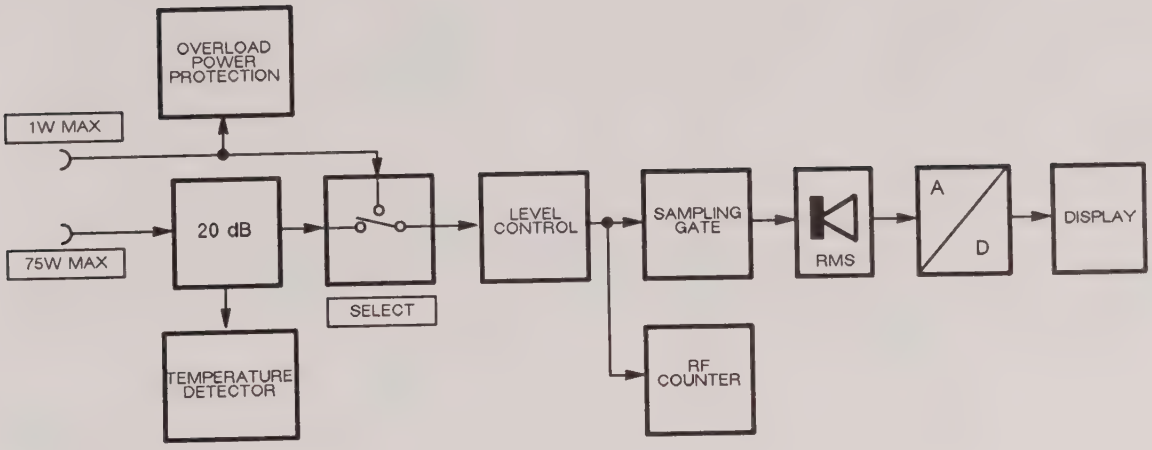


Fig. 4-4 RF power meter block diagram.

MODULATION METER

The modulation meter simplified block diagram is shown in Fig. 4-5. An input from the transmitter connected to the N-type socket is passed by the SELECT switch to the processor operated level control circuit. Outputs are taken to the r.f. counter and to a sampling gate. The gate is switched at a sub-harmonic of the input frequency to produce a 110 kHz i.f. which takes one of two paths. When a.m. demodulation is selected, the i.f. is first divided down and then detected. When f.m. or ø.m. demodulation is selected, the signal is frequency to voltage converted which results in a voltage varying at the modulation rate. For ø.m. the signal additionally passes through a de-emphasis stage. Switch selectable 0.3 to 3.4 kHz band-pass and 300 Hz or 15 kHz low-pass filters follow. At this point, outputs are taken to the a.f. counter, to the rear panel DE MOD OUT socket and to an internal loudspeaker used for audio monitoring. In the main signal path, processor operated peak detectors follow which measure the modulation peaks and troughs. The signal is finally analogue-to-digital converted and the modulation is displayed.

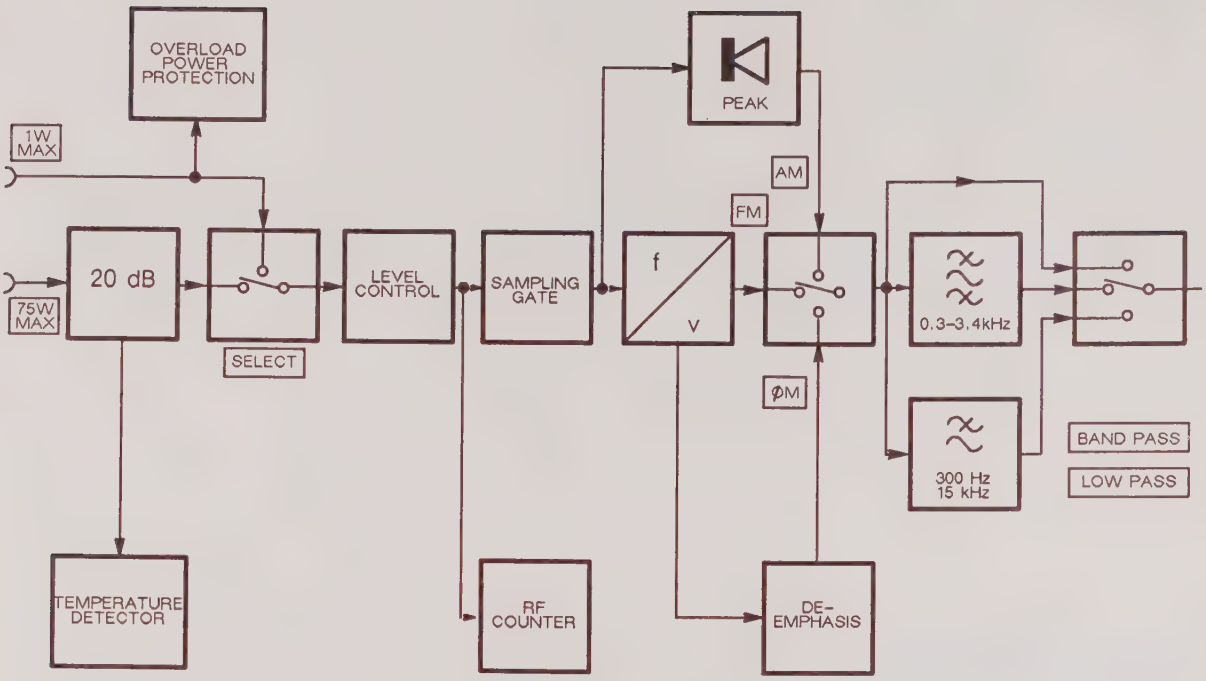
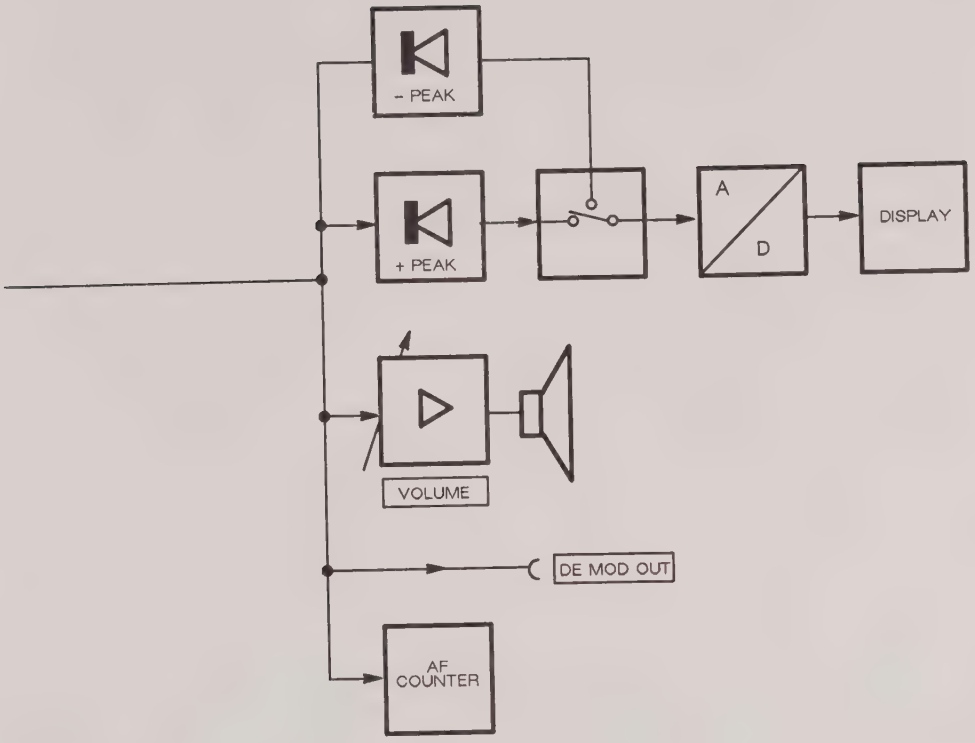


Fig. 4-5 Modulation meter block diagram.



DISTORTION METER

The distortion meter simplified block diagram is shown in Fig. 4-6. For a TX measurement, the modulated input from the transmitter connected to the b.n.c. socket for low power or to the N-type socket for high power is passed by the SELECT switch to the processor operated level control circuit. Outputs are taken to the r.f. counter and to a sampling gate. The gate is switched at a sub-harmonic of the input frequency to produce a 110 kHz i.f. which takes one of two paths. When a.m. demodulation is selected, the i.f. is first divided down and then detected. When f.m. or ø.m. demodulation is selected, the signal is frequency to voltage converted which results in a voltage varying at the modulation rate. For ø.m. the signal additionally passes through a de-emphasis stage.

If an RX measurement is being made, the receiver's audio output at a frequency of 1 kHz is connected to the AF INPUT socket. This is fed through a capacitor by the AC key and then the level is adjusted by processor operated level control circuits prior to the signal being selected for measurement.

The signal is fed through a 300 Hz to 3.4 kHz band-pass filter and then to a switched 1 kHz band-stop filter. When this is switched in it removes the 1 kHz fundamental frequency and so leaves the harmonic distortion for measurement. An r.m.s. detector follows whose output is analogue-to-digital converted and then the distortion factor or SINAD is calculated and displayed.

The distortion-type measurements are:–

$$S/N = 20 \log \frac{\text{Signal}}{\text{Noise}} \text{ (dB)}$$

where noise is measured in a 0.3 to 3.4 kHz bandwidth and understood to include all components apart from signal and harmonic distortion.

$$\text{Distortion factor} = 20 \log \frac{\text{Distortion products + noise}}{\text{Signal + distortion + noise}} \times 100\%$$

$$\text{SINAD} = 20 \log \frac{1}{\text{Distortion factor}} \text{ (dB)}$$

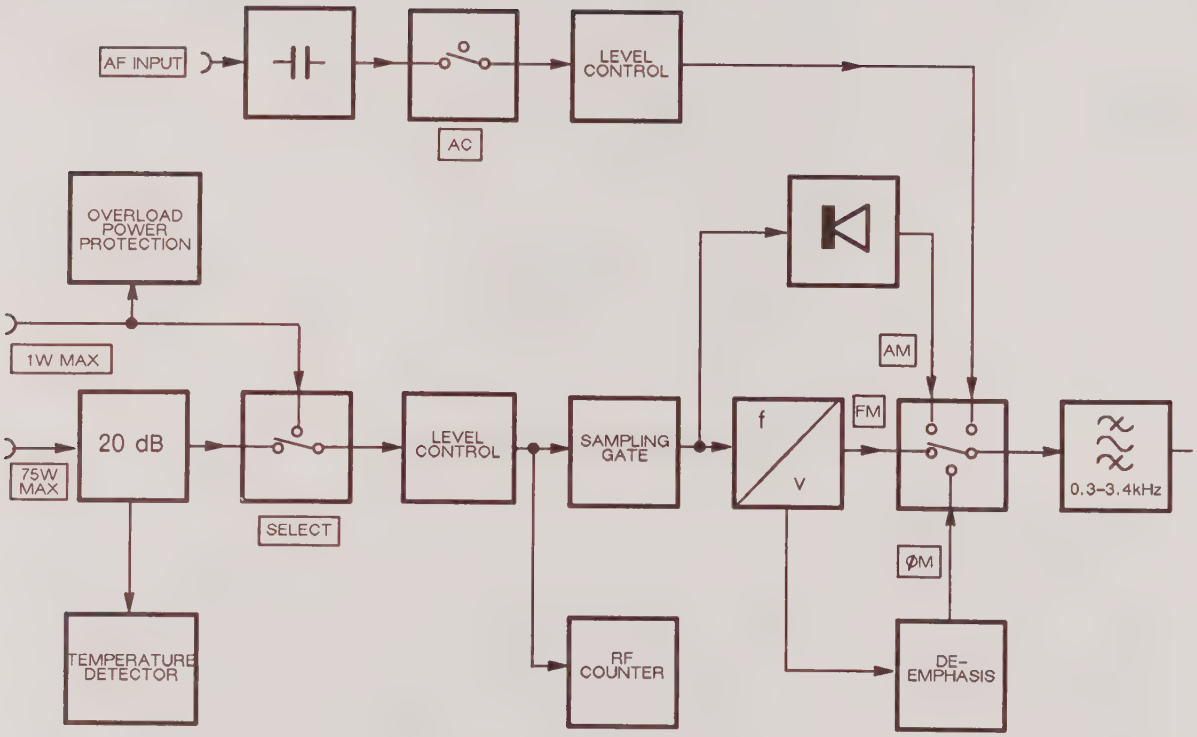
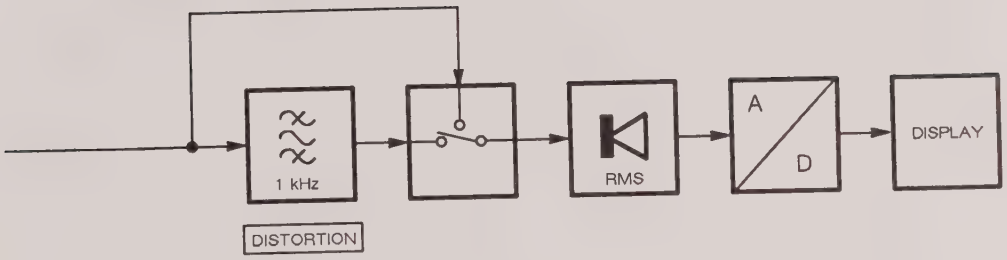


Fig. 4-6 Distortion meter block diagram.


1 kHz
RMS
A
D
DISPLAY
DISTORTION

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EQUIPMENT...2955

TITLE.....Radio Communications Test Set

PART NO.....52955-900A

ACCOMPANYING
DOCUMENTS...Chap. 5-0. p.7/8)from H 52955-900A Vol. 2
Chap. 5-1

MANUAL CHANGE

ACCEPTANCE TESTS (temporary edition)

The attached extract from the service manual comprises a series of test procedures which enable you to check that the main electrical performance characteristics of the test set comply with those given in the Performance Data section of Chap. 1. Test equipment recommended for this purpose is also listed.

All tests may be performed with the covers in place and are intended to be carried out in the order given.

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Performance testing	Chap. 5-1

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND.

TABLE 1 TEST EQUIPMENT FOR PERFORMANCE CHECKS

Description	Minimum specification	Example
Spectrum Analyzer	Frequency range: 0.4 - 1000 MHz	Marconi TF 2370 + TK 2373
Power Meter & Sensors	Frequency range: 0.4 - 1000 MHz Power measurement range: -65 to +20 dB Accuracy: better than 0.15 cB	Marconi 6960 + 6912 & 6920 Sensors
Modulation Meter	AM measurement: 1.5 - 400 MHz FM measurement: 0.5 - 100 MHz AM accuracy: 1% at 1 kHz rate, 2.5% at rates 50 Hz - 15 kHz FM accuracy: 2% D-mod output: 0.3-3.4 kHz weighted filter	Marconi 2305
Distortion Meter	0.2% distortion accuracy	Marconi 2331A
Frequency Counter	Frequency range: 0.4 - 1000 MHz 1 MHz Std. O/P	Marconi 2435
Synthesized LF Generator	20 Hz - 20 kHz sine and square level 0 to 2 V RMS 1 MHz Std. O/P	HP 3325A
DVM	20 Hz - 20 kHz, 0.02% accuracy RMS DC measurement down to 1 mV	Datron 1065A
Counter/Timer	50 Hz - 15 kHz, accuracy better than 0.005 Hz	Marconi 2438
Audio Analyzer	Sinad measurement psophometric filter	HP 8903A
AC/DC Calibrator	DC 0 - 100 V, AC 1 kHz, level accuracy better than 0.05%	Rotek 3950
Signal Generator	Synthesized freq.: 1.5 - 1000 MHz, 1 MHz Std. O/P. RF level: 13 dBm FM: 0 - 25 kHz deviation AM: 0 - 90% Ext. mod. 50 Hz - 10 kHz, Ext. Std. I/P	Marconi 2019A
Power Splitter	6 dB splitter, 50 Ω 1.5 - 400 MHz	HP 1166/A
RF Power Source	Overall uncertainty of 2% up to 500 MHz, 3 % up to 1000 MHz	See RF Power Perform. Check
Standard Frequency Source	Frequency accuracy better than ±5 parts in 10^{10}	Rubidium or Caesium ref.
Oscilloscope Power Supply	100 MHz dual channel Capable of supplying 55 W at 11 V	Tektronix 2235 Coutant LB1000.2
50 Ω termination	50 Ω ±1% 1/2 W	Suhner

Chapter 5-1

PERFORMANCE TESTING

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GENERAL

1. This section contains information for keeping the instrument in good working order and checking its overall performance. For these purposes this chapter should be read in conjunction with the Technical Description, Chap. 4, and the Circuit Diagrams, Chap. 7.

2. Integrated circuits and semiconductor devices are used throughout this instrument and, although these have inherent long term reliability and mechanical ruggedness, they are susceptible to damage by overloading, reversed polarity and excessive heat or radiation. Avoid hazards such as prolonged soldering, strong r.f. fields or other forms of radiation and the use of insulation testers.

3. In case of difficulties which cannot be resolved with the aid of this book, please contact our Service Division at the address given inside the rear cover, or your nearest Marconi Instruments representative. Always quote the type and serial number found on the data plate at the rear of the instrument.

PERFORMANCE TESTS

4. Test procedures described in this chapter may be simplified and of restricted range compared with the comprehensive factory test facilities which are necessary to demonstrate complete compliance with the specifications.

5. Performance limits quoted are for guidance and should not be taken as guaranteed performance specifications unless they are also quoted in the Performance Data in Chap. 1.

6. When verifying that the instrument meets the stated performance limits, allowance must always be made for the uncertainty of the test equipment used.

OSCILLOSCOPE PERFORMANCE CHECKS

7. The oscilloscope performance checks comprise a.f. level d.c. offset, a.f. level gain, and demodulated f.m. and a.m. gain.

Frequency range & accuracy specification

8. This section checks that the instrument performs to the following specification:-

DC to 50 kHz (3 Hz on a.c.) ±5% accuracy
FM deviation ±10% accuracy
AM depth ±10% accuracy

Frequency range & accuracy test gear

9. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
AC/DC Calibrator	Accuracy 1.5% d.c.	Rotek 3950
Signal Generator	100 MHz, a.m./f.m. Level 7 dBm	Marconi 2019A
Modulation meter	AM/FM 100 MHz Accuracy >3%	Marconi 2305
Power splitter	6 dB, 100 MHz	HP 11667A

Checking a.f. level d.c. offset

10. Proceed as follows:-

(1) On the u.u.t. select RX and SCOPE, d.c. coupled. Short out the AF INPUT socket.

(2) Use the oscilloscope vertical POSITION control to bring the trace onto the centre of the graticule.

(3) Scan through the vertical scale ranges and check that the trace does not move more than 1/4 division between ranges.

Checking a.f. level gain

11. Proceed as follows:-

(1) Set the u.u.t. to RX, SCOPE, d.c. coupled, 50 kHz LOW PASS filter, distortion/SINAD/SN off.

(2) Use the vertical POSITION control to move the trace to the bottom dotted graticule line.

(3) Connect the equipment as shown in Fig. 1.

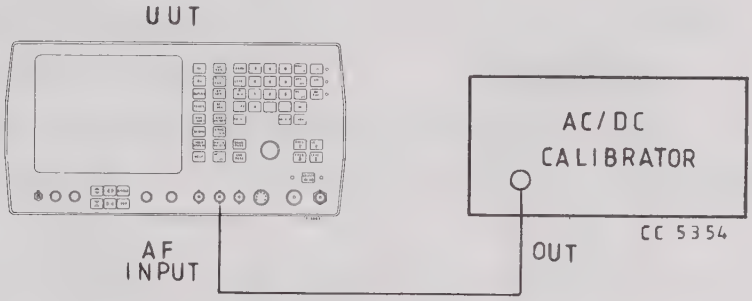

Fig. 1 Test equipment connections for oscilloscope a.f. level gain performance checks

(4) Set the oscilloscope to 2 V/div. Set the calibrator to output + d.c. and adjust the level until the oscilloscope trace appears on the top dotted graticule line. Check that the calibrator output is within 9.5 to 10.5 V.

(5) Repeat step (4) above for the remaining oscilloscope ranges and calibrator limits shown in Table 2.

TABLE 1 AF LEVEL GAIN - OSCILLOSCOPE

Scope range	Nominal d.c. Volts	Calibrator limits
2 V/div	10 V	9.5 - 10.5 V
1 V/div	5 V	4.75 - 5.25 V
500 mV/div	2.5 V	2.375 - 2.625 V
50 mV/div	0.25 V	0.2375 - 0.2625 V

Checking demodulated f.m. gain

12. Proceed as follows :-

(1) Connect the equipment as shown in Fig. 2.

(2) Set the u.u.t. to TX, FM, SCOPE, 0.3 - 3.4 kHz BAND PASS filter, b.n.c. input socket.

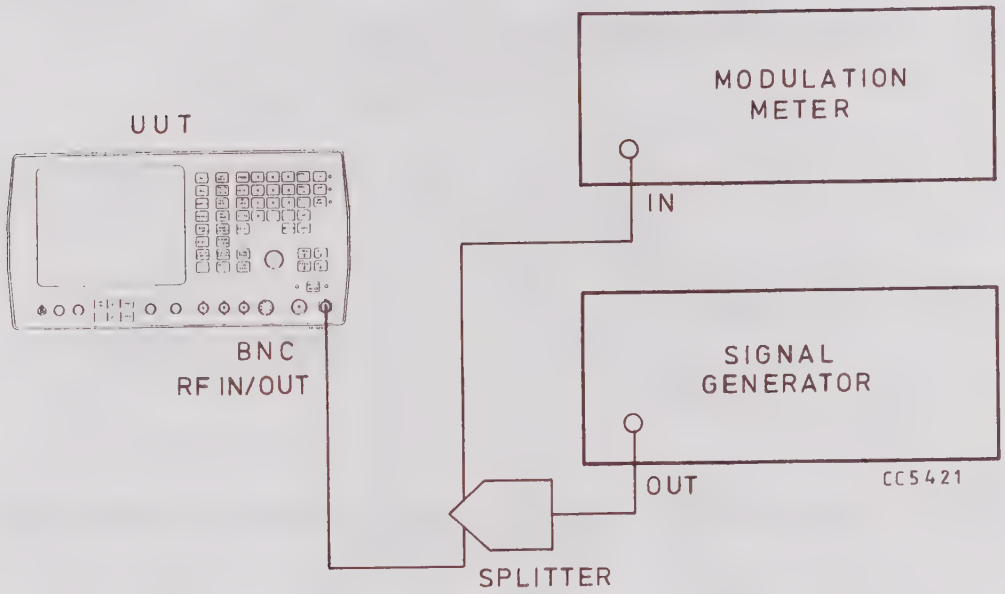

Fig. 2 Test equipment connections for oscilloscope demodulated f.m. gain performance checks.

(3) Set the signal generator to carrier frequency 100 MHz, level 7 dBm, f.m., 1 kHz internal modulation rate.

(4) Set the modulation meter to monitor f.m., (p-p)/2, in a 0.3 - 3.4 kHz bandwidth.

(5) Set the u.u.t. oscilloscope range to ±30 kHz deviation. Adjust the signal generator f.m. deviation until the f.m. deviation on the oscilloscope is shown as 20 kHz. Check on the modulation meter that the deviation limits are within 18.0 to 22.0 kHz.

(6) Repeat step (5) above for the remaining oscilloscope ranges and deviation limits shown in Table 3.

TABLE 2 DEMODULATED FM GAIN - OSCILLOSCOPE

Scope range ± deviation	FM deviation on scope	Modulation meter limits
30 kHz	20 kHz	18.0 - 22 .0 kHz
15 kHz	10 kHz	9.0 - 11.0 kHz
6 kHz	4 kHz	3.6 - 4.4 kHz
3 kHz	2 kHz	1.8 - 2.2 kHz
1.5 kHz	1 kHz	0.9 - 1.1 kHz

Checking demodulated a.m. gain

13. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 2.

(2) Set the u.u.t. to TX, AM, SCOPE, 0.3 - 3.4 kHz BAND PASS filter, b.n.c. input socket.

(3) Set the signal generator to carrier frequency 100 MHz, level 7 dBm, a.m., 1 kHz internal modulation rate.

(4) Set the modulation meter to monitor a.m., (p-p)/2, in a 0.3 - 3.4 kHz bandwidth.

(5) Set the u.u.t. oscilloscope range to 20%/div. Adjust the signal generator depth until the waveform on the oscilloscope is shown as 80%. Check on the modulation meter that the depth limits are within 72 to 88%.

(6) Repeat step (5) above for the remaining oscilloscope ranges and modulation depths shown in Table 4.

TABLE 3 DEMODULATED AM GAIN - OSCILLOSCOPE

Scope range (% a.m./div)	AM depth on scope	Modulation meter limits
20	80%	72 - 88%
10	40%	36 - 44%
5	20%	18 - 22%

MODULATION METER PERFORMANCE CHECKS

14. The modulation meter performance checks comprise demodulation distortion, a.m. and f.m. monitor accuracy, a.m. and f.m. bar chart and scope, and input sensitivity.

Demodulation distortion specification

15. This section checks that the instrument performs to the following specification:-

<2% distortion at 30% a.m. and 1 kHz mod. freq. (in a 0.3 - 3.4 kHz bandwidth). <2% distortion at 5 kHz deviation and 1 kHz mod freq. (in a 0.3 - 3.4 kHz bandwidth).

Demodulation distortion test gear

16. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Signal generator	1.5 - 1000 MHz, f.m. & a.m.	2019A
Distortion meter	0.2% distortion accuracy at 1 kHz.	TF2331A

Checking demodulation distortion

17. Proceed as follows but note that the distortion of the modulated signal being applied will affect the de- mod distortion and therefore should not be more than 0.5%:-

(1) Connect the equipment as shown in Fig. 3.

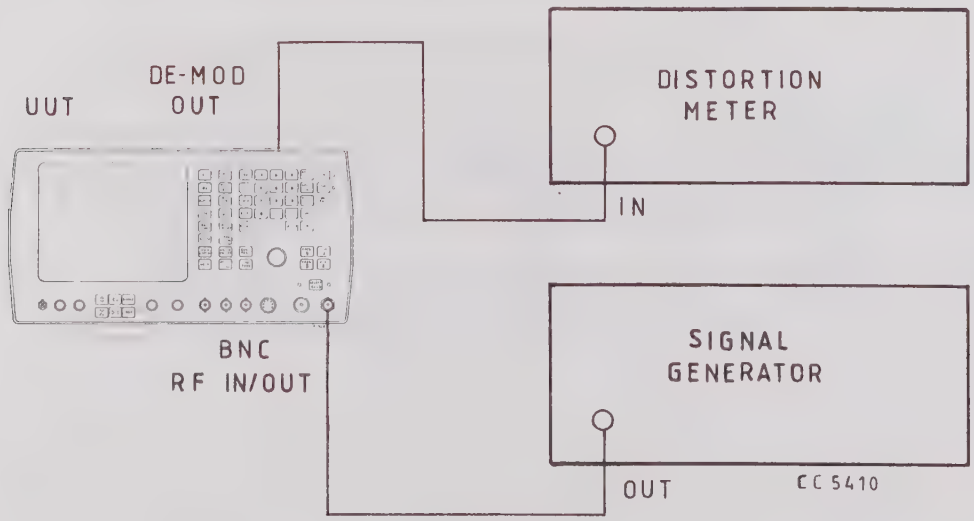

Fig. 3 Test equipment connections for modulation meter demodulation distortion performance checks

(2) Set the u.u.t. to TX, AM, 0.3 - 3.4 kHz BAND PASS filter, b.n.c. input socket.

(3) Set the signal generator to carrier frequency 100 MHz, level 0 dBm, 30% a.m., 1 kHz internal modulation rate.

(4) Tune in the distortion meter and check that the distorion indicated is <2%.

(5) Change the u.u.t. modulation to f.m.

(6) Change the signal generator modulation to 5 kHz f.m., modulation rate 1 kHz.

(7) Tune in the distortion meter and check that the distortion indicated is <2%.

AM monitor accuracy specification

18. This section checks that the instrument performs to the following specification:-

±6% of reading ±1 digit at 1 kHz. ±8.5% of reading ±1 digit (50 Hz-10 kHz).

AM monitor accuracy test gear

19. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Signal generator	1.4-400 MHz, a.m. capability ext. mod. 50 Hz-10 kHz, 0-90%. RF level 13 dBm.	Marconi 2019A
Modulation meter	1.5-400 MHz. AM accuracy 1%.	Marconi 2305
LF synthesizer	50 Hz-10 kHz. 1 V r.m.s. level.	HP 3325A
Power splitter	6 dB splitter. 50 Ω, 1.5-400 MHz.	HP 11667A

Checking a.m. monitor accuracy

20. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 4.

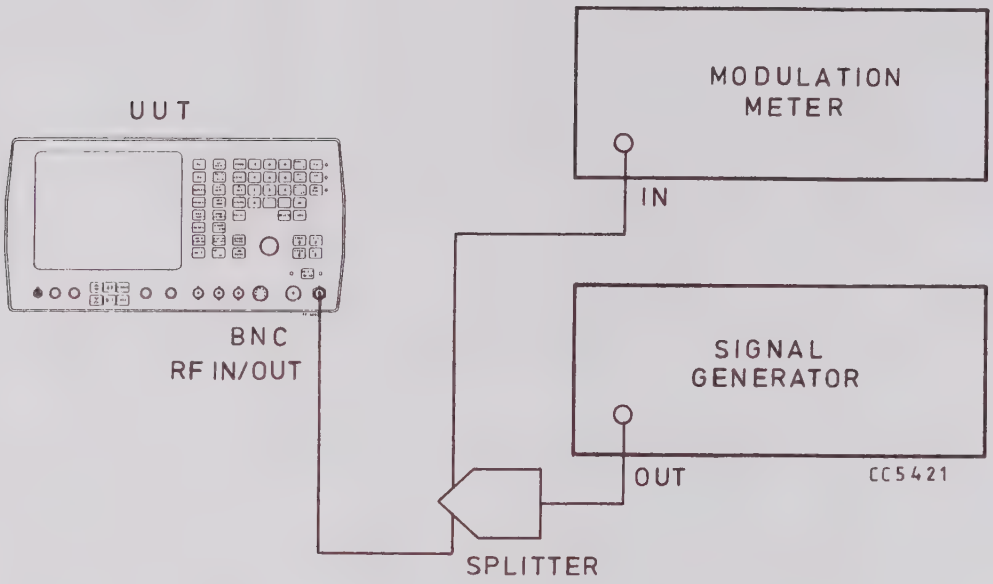

Fig. 4 Test equipment connections for modulation meter a.m. & f.m. monitor accuracy performance checks

(2) Set the u.u.t. to TX, AM, 0.3 - 3.4 kHz BAND PASS filter, b.n.c. input socket.

(3) Set the signal generator to carrier frequency 100 MHz, level 7 dBm, 80% a.m., 1 kHz internal modulation rate.

(4) Set the modulation meter to monitor a.m. in a 0.3 - 3.4 kHz bandwidth.

(5) Check that the a.m. level indicated on the u.u.t. display is within ±6% of reading ±1 digit of modulation depth indicated on the modulation meter.

(6) Repeat the above for modulation depths from 0 to 90% and carrier frequencies between 1.5 and 100 MHz.

(7) Repeat for modulation depths from 0 to 80% and carrier frequencies between 1.5 and 400 MHz.

Checking operation of a.m. bar chart and scope

21. Proceed as follows:=-

(1) Connect the equipment as shown in Fig. 5.

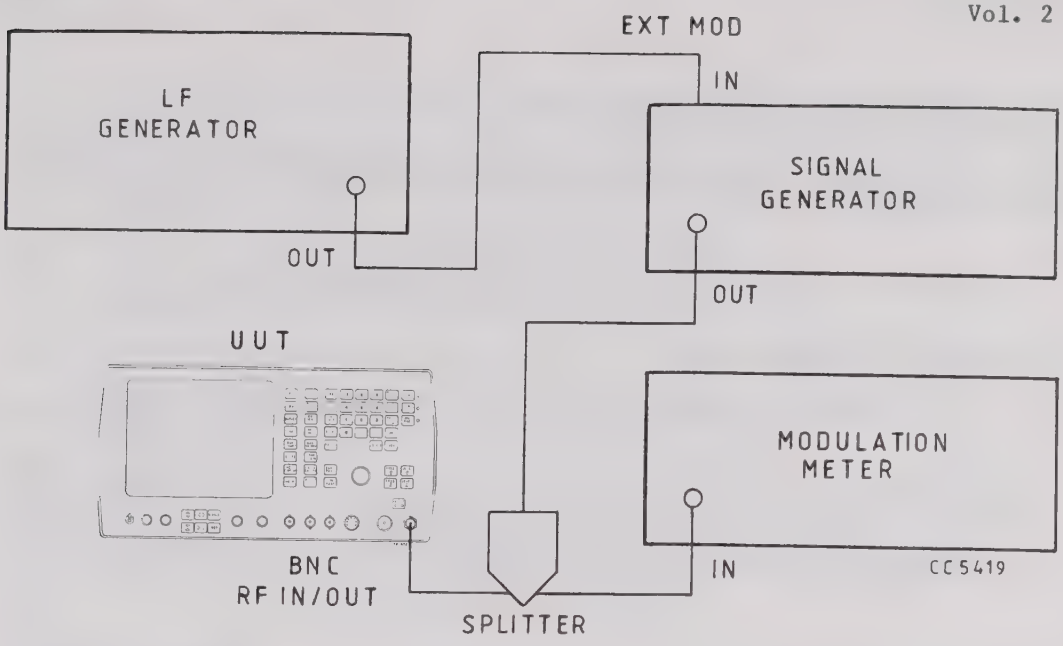

Fig. 5 Test equipment connections for modulation meter a.m. & f.m. bar chart and scope performance checks

(2) Set the u.u.t. to TX, AM, 15 kHz LOW PASS filter, b.n.c. input socket.

(3) Set the signal generator to carrier frequency 100 MHz, level 7 dBm, 80% external a.m. at a 10 kHz modulation rate (from the l.f. generator).

(4) Set the modulation meter to monitor a.m. in a 30 Hz to 50 kHz bandwidth.

(5) Set the synthesized l.f. generator to give a 10 kHz sinewave. Adjust the level to suit the external modulation input of the signal generator.

(6) Check that the a.m. level indicated on the u.u.t. display is within ±8.5% of reading ±1 digit of modulation depth indicated on the modulation meter.

(7) Repeat the above for modulation rates between 50 Hz and 10 kHz. Ensure that the correct filters are selected on both the u.u.t. and the modulation meter according to the modulation rate being used.

FM monitor accuracy specification

22. This section checks that the instrument performs to the following specification:-

±6% ±1 digit at 1 kHz. ±8.5% over range 50 Hz-10 kHz.

FM monitor accuracy test gear

23. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Signal generator	1.5-1000 MHz, level 13 dBm. FM 0-25 kHz deviation. FM ext. mod. 50 Hz-10 kHz.	Marconi 2019A
Modulation meter	1.5-1000 MHz. FM accuracy 1%.	Marconi 2305
LF synthesizer	50 Hz-10 kHz. 1 V r.m.s. level.	HP 3325A
Power splitter	6 dB splitter. 50 Ω, 1.5-1000 MHz.	HP 11667A

Checking f.m. monitor accuracy

24. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 4.

(2) Set the u.u.t. to TX, FM, 0.3 - 3.4 kHz BAND PASS filter, distortion/SINAD/SN off, b.n.c. input socket.

(3) Set the signal generator to carrier frequency 500 MHz, level 13 dBm, 25 kHz f.m., 1 kHz internal modulation rate.

(4) Set the modulation meter to monitor f.m. in a 0.3 to 3.4 kHz bandwidth.

r (5) Check that the f.m. level indicated on the u.u.t. display is within ±6% of reading ±1 digit of modulation deviation indicated on the modulation meter.

(6) Repeat the above for random carrier frequencies from 1.5 to 1000 MHz and random deviation between 0 and 25 kHz.

Checking operation of f.m. bar chart and scope

25. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 5.

(2) Set the u.u.t. to TX, FM, 15 kHz LOW PASS filter, b.n.c. input socket.

(3) Set the signal generator to carrier frequency 500 MHz, level 13 dBm, 25 kHz external f.m. at 10 kHz modulation (from the l.f. generator).

(4) Set the modulation meter to monitor f.m. in a 30 Hz to 50 kHz bandwidth.

(5) Set the synthesized l.f. generator to give a 10 kHz sinewave. Adjust the level to suit the external modulation input of the signal generator.

(6) Check that the modulation level indicated on the u.u.t. display is within ±8.5% of the modulation indicated on the modulation meter. Ensure that the correct filters are selected on both the u.u.t. and the modulation meter according to the modulation rate being used.

Input sensitivity specification

26. This section checks that the instrument performs to the following specification:-

N-type socket sensitivity 5 mW. In one port duplex mode, sensitivity is reduced to 20 mW.

Input sensitivity test gear

27. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Signal generator	Synthesized freq. 1.5-1000 MHz. 1 MHz standard output. Level 13 dBm, f.m.	Marconi 2019A
Power meter & sensor	1.5-1000 MHz. -30 to +20 dBm.	Marconi 6960 + Sensor 6912

Checking input sensitivity

28. Proceed as follows:-

(1) Set the u.u.t. to TX, FM, 0.3 - 3.4 kHz BAND PASS filter, N-type input socket.

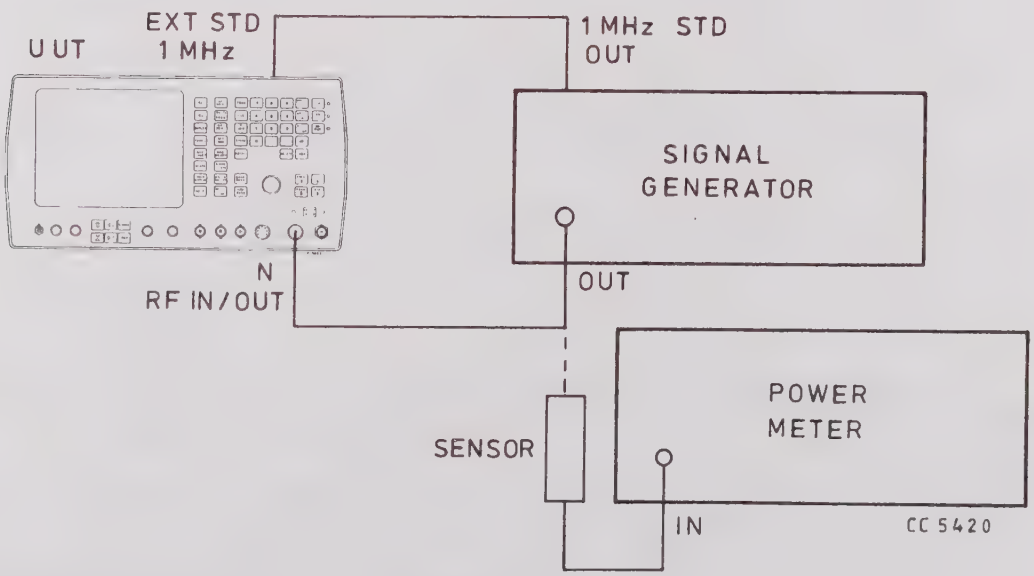

Fig. 6 Test equipment connections for modulation meter input sensitivity performance checks.

(2) Set the signal generator to carrier frequency 400 MHz, modulation 10 kHz f.m., modulation rate 1 kHz.

(3) Connect the power meter to the signal generator output (see Fig. 6) and adjust the r.f. level to give 5 mW indication on the power meter.

(4) Connect the signal generator to the u.u.t. N-type input socket (see Fig. 4) and check that the u.u.t. modulation meter reads 10 kHz f.m. deviation.

(5) Set the u.u.t. to one port duplex mode and repeat the above checks with the signal generator output set to 20 mW.

VOLTMETER PERFORMANCE CHECKS

29. The voltmeter performance checks comprise d.c. and a.f. level meter accuracy, and a.f. level meter frequency response.

DC and a.f. level meter accuracy specification

30. This section checks that the instrument performs to the following specification:-

±3% of reading ±3 mV ±1 digit

Level meter accuracy test gear

31. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
AC/DC calibrator	DC 0-100 V, a.c. 1 kHz. Level accuracy better than 0.05%.	Rotek 3950

Checking d.c. and a.f. level meter accuracy

32. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 7.

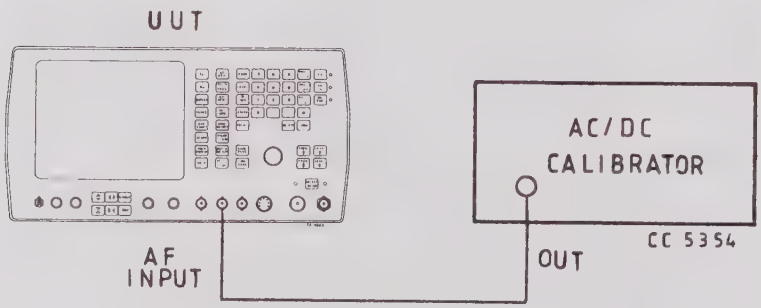

Fig. 7 Test equipment connections for voltmeter d.c. & a.f. level accuracy performance checks

(2) Set the u.u.t. to audio test, distortion off, 50 kHz LOW PASS filter, d.c. coupled.

(3) Set the calibrator to give 1.000 V d.c.

(4) Check that the reading on the a.f. voltmeter indicates the voltage set on the calibrator ±3% of reading ±3 mV ±1 digit.

(5) Repeat for random d.c. levels up to 100 V.

(6) Check the operation of the bar chart and oscilloscope.

(7) Set the u.u.t. to a.c. coupled.

(8) Set the calibrator to give 1.000 V a.c. at 1 kHz.

(9) Check that the reading on the a.f. voltmeter indicates the voltage set on the calibrator ±3% of reading ±3 mV ±1 digit.

(10) Repeat at 1 kHz for random levels up to 100 V.

AF level meter frequency response specification

33. This section checks that the instrument performs to the following specification:-

±3% of reading ±3 mV ±1 digit

AF level meter frequency response test gear

34. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
LF synthesizer	50 Hz-20 kHz. Level 2 V r.m.s.	HP 3325A R & S SPN
RMS d.v.m.	50 Hz-20 kHz. Accuracy better than 0.02%.	Datron 1065A
50 Ω termination	50 Ω ±1%, 1/2 W.	Suhner

Checking a.f. level meter frequency response

35. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 8.

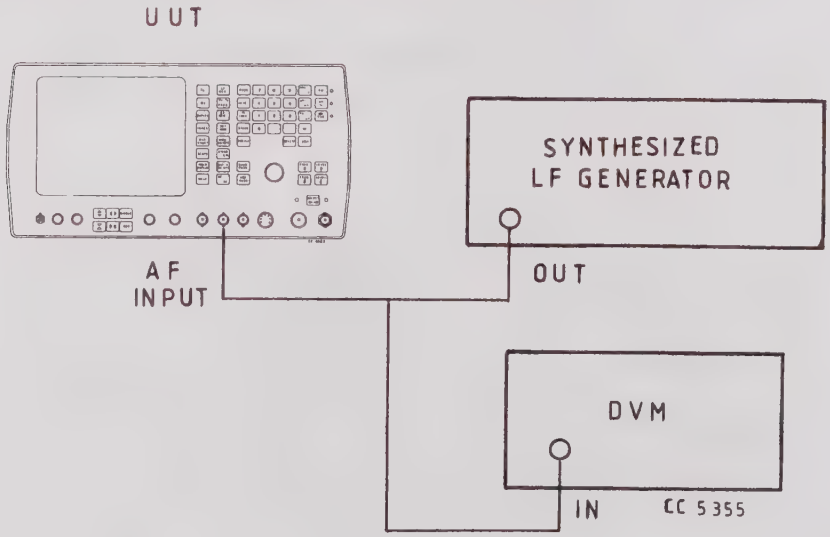

Fig. 8 Test equipment connections for voltmeter frequency response performance checks

(2) Set the u.u.t. to audio test, distortion off, 50 kHz LOW PASS filter, a.c. coupled.

(3) Set the synthesized l.f. generator to give a 1 kHz sinewave at 1 V r.m.s. into 50 Ω.

(4) Set the d.v.m. to monitor a.c., r.m.s.

(5) Check that the reading on the a.f. voltmeter is within ±3% of reading ±3 mV ±1 digit of reading indicated on the d.v.m.

(6) Repeat the above for l.f. generator frequencies between 50 Hz and 20 kHz.

RF FREQUENCY METER PERFORMANCE CHECKS

36. The r.f. frequency meter performance checks comprise accuracy and input sensitivity.

Accuracy specification

37. This section checks that the instrument performs to the following specification:-

Accuracy: As internal standard ±1 digit

Accuracy test gear

38. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Signal generator	Synthesized freq. 1.5-1000 MHz. 1 MHz standard output.	Marconi 2019A

Checking accuracy

39. Note that the following method checks the r.f. frequency meter (internal counters/dividers) is working correctly. However, overall accuracy depends upon the correct setting of the internal 10 MHz standard (see under 'Adjustments' in the board checks for AC1). Proceed as follows:-

(1) Connect the equipment as shown in Fig. 9.

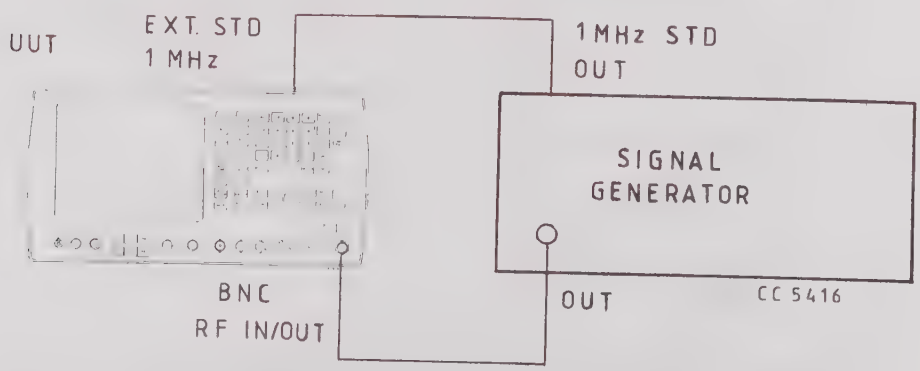

Fig. 9 Test equipment connections for r.f. frequency meter accuracy performance checks

(2) Set the u.u.t. to TX, b.n.c. input socket.

(3) Set the signal generator to carrier frequency 1000 MHz, level 7 dBm, modulation off.

(4) Check that the u.u.t. indicates the signal generator frequency ±1 count.

(5) Repeat the above for frequencies between 1.5 and 1000 MHz.

Input sensitivity specification

40. This section checks that the instrument performs to the following specification:-

N-type socket sensitivity 5 mW. In one port duplex mode, sensitivity is reduced to 20 mW.

Input sensitivity test gear

41. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Signal generator	Synthesized freq. 1.5-1000 MHz. 1 MHz standard output. Level 13 dBm, f.m.	Marconi 2019A
Power meter & sensor	1.5-1000 MHz. -30 to +20 dBm.	Marconi 6960 + Sensor 6912

Checking input sensitivity

42. Proceed as follows:-

(1) Set the u.u.t. to TX, N-type input socket.

(2) Set the signal generator to carrier frequency 100 MHz, modulation off.

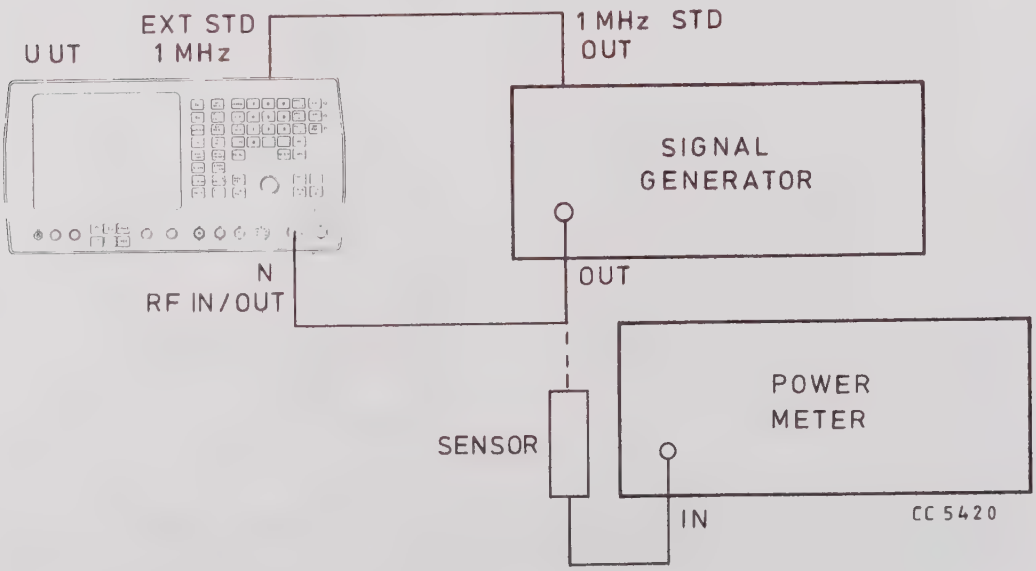

Fig. 10 Test equipment connections for r.f. frequency meter input sensitivity performance checks

(3) Connect the power meter to the signal generator output (see Fig. 10) and adjust the r.f. level to give 5 mW indication on the power meter.

(4) Connect the signal generator to the u.u.t. N-type input socket (see Fig. 2). Check that the u.u.t. frequency meter is locked and stable and indicates the frequency set on the signal generator ±10 Hz.

(5) Repeat the above for frequencies from 1.5 to 1000 MHz.

AF FREQUENCY METER PERFORMANCE CHECKS

43. The a.f. frequency meter performance checks comprise frequency accuracy and sensitivity.

Frequency accuracy and sensitivity specification

44. This section checks that the instrument performs to the following specification:-

As internal standard ±1 digit ±0.1 Hz/0.02%. Sensitivity 50 mV.

Frequency accuracy and sensitivity test gear

45. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
LF synthesizer	20 Hz-20 kHz. 1 MHz standard output.	HP 3325A
50 Ω termination	50 Ω, 1/2 W.	Suhner
DVM	0.5% accuracy.	Datron 1065A

Checking frequency accuracy and sensitivity

46. Note that the following method checks the a.f. frequency meter is working correctly. However, overall accuracy depends upon the correct setting of the internal 10 MHz standard (see under 'Adjustments' in the board checks for AC1. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 11.

(2) Set the u.u.t. to audio test, distortion off, 50 kHz LOW PASS filter, a.c. coupled.

(3) Set the synthesized l.f. generator to give a 20 kHz sinewave at 50 mV r.m.s.

(4) Set the d.v.m. to read a.c. and r.m.s.

(5) Adjust the l.f. synthesizer output level until the d.v.m. indicates 50 mV.

(6) Check that the frequency meter on the u.u.t. indicates the frequency set on the synthesizer ±1 digit ±0.1 Hz/0.02%.

(7) Repeat the above for random l.f. synthesizer frequencies between 20 Hz and 20 kHz.

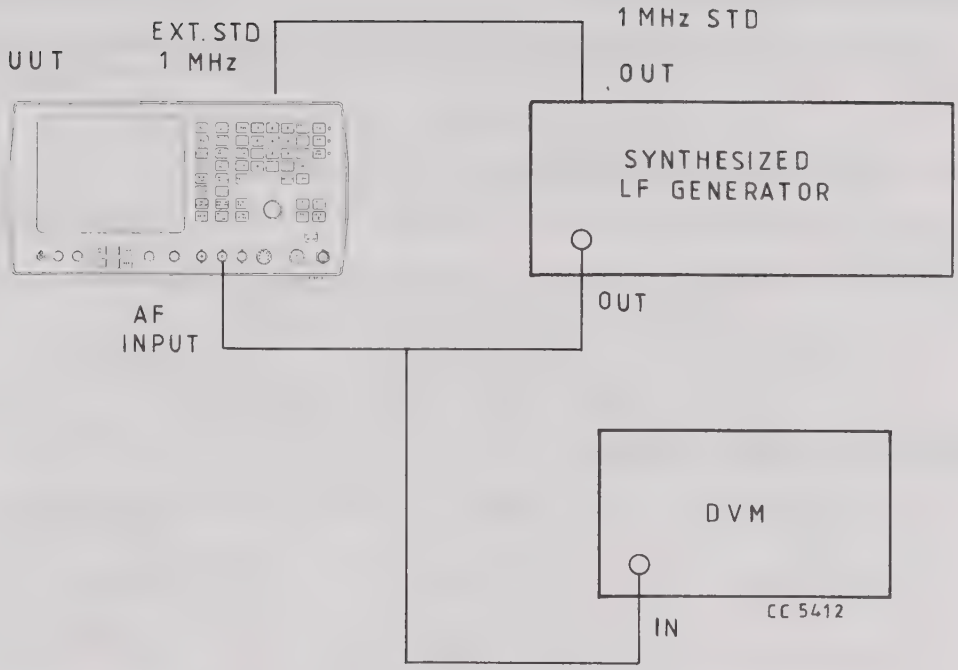

Fig. 11 Test equipment connections for a.f. frequency meter accuracy and sensitivity performance checks

AF GENERATOR PERFORMANCE CHECKS

47. The a.f. generator performance checks comprise output level accuracy, distortion, frequency accuracy, d.c. offset, residual noise, and spurious signals.

Output level accuracy specification

48. This section checks that the instrument performs to the following specification:-

Range : 1 mV-2.55 V up to 5 kHz. 1 mV-2 V up to 15 kHz. Accuracy: ±5% ±1 count, 50 Hz-15 kHz.

Output level accuracy test gear

49. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
RMS voltmeter	AC voltage 20 Hz-20 kHz. Accuracy better than 0.5% of reading, 50 mV-2.55 V.	Datron 1065A

Checking output level accuracy

50. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 12.

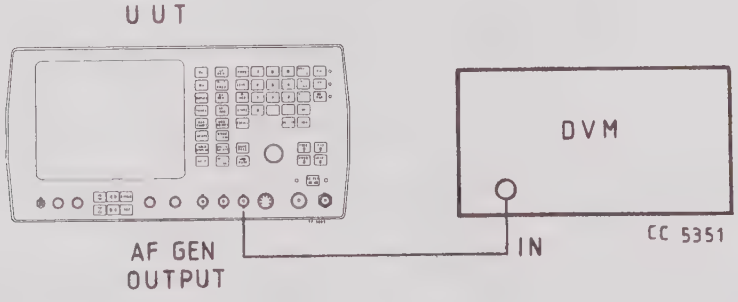

Fig. 12 Test equipment connections for a.f. generator output level accuracy performance checks

(2) Set the u.u.t. to AF GEN, frequency 1 kHz, level 1.00 V.

(3) Check that the voltmeter reads the a.f. generator level set on the u.u.t. ±5% ±1 count.

(4) Repeat for random a.f. generator frequencies and levels.

Distortion specification

51. This section checks that the instrument performs to the following specification:-

Less than 2% up to 15 kHz. Less than 1% for the 1 kHz fixed source.

Distortion test gear

52. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Distortion meter	Frequency range 50 Hz-15 kHz. Better than 0.2% distortion.	Marconi TF 2331A

Checking distortion

53. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 13.

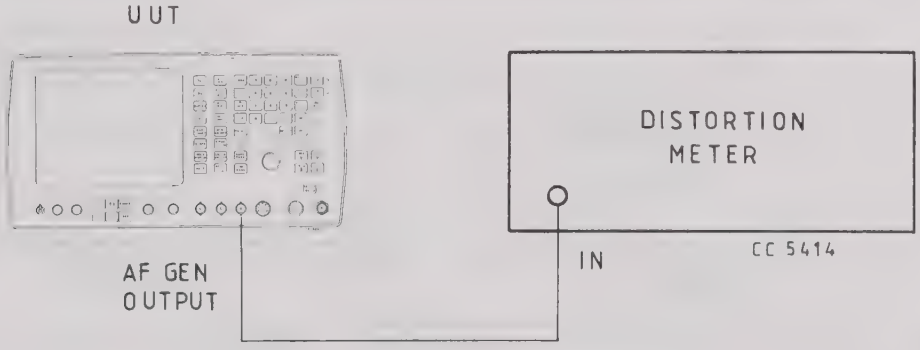

Fig. 13 Test equipment connections for a.f. generator distortion performance checks

(2) Set the u.u.t. to AF GEN, frequency 5 kHz, level 2 V.

(3) Tune in the distortion meter and check that the distortion indicated is less than 2%.

(4) Repeat for random levels and frequencies between 50 Hz and 15 kHz.

(5) Change the u.u.t. a.f. generator frequency to 1 kHz.

(6) Tune in the distortion meter and check that the distortion indicated is less than 1%.

AF generator frequency accuracy specification

54. This section checks that the instrument performs to the following specification:-

±0.01 Hz from 50 Hz to 3.25 kHz. ±0.1 Hz from 3.25 kHz to 15 kHz.

Frequency accuracy test gear

55. The following test gear is required to check to the above specification:-

Description	Minimum spec.	Example
Frequency counter/timer	50 Hz-15 kHz, Accuracy better than 0.1 Hz.	Marconi 2438

Checking frequency accuracy

56. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 14.

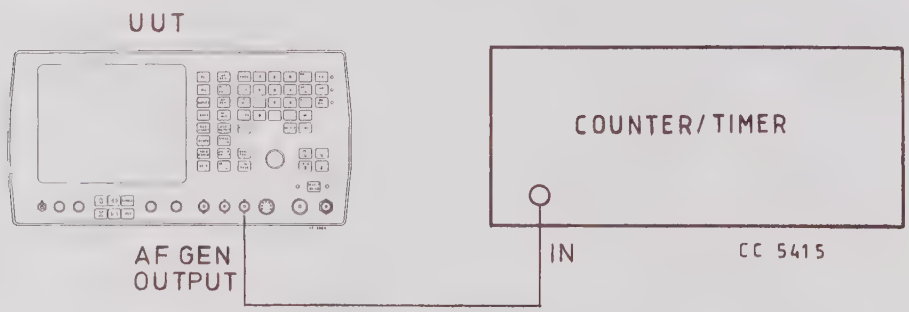

Fig. 14 Test equipment connections for a.f. generator frequency accuracy performance checks

(2) Set the u.u.t. to AF GEN, frequency 15 kHz, level 1 V.

(3) Set the counter/timer to read period (to gain the required resolution).

(4) Check that the counter/timer reads between 66666.2 and 66667.1 ns (15 kHz ±0.1 Hz).

(5) Repeat the above for random frequencies between 3.25 kHz and 15 kHz checking on the counter/timer that the frequency selected is within ±0.1 Hz.

(6) Repeat for random frequencies between 50 Hz and 3.25 kHz checking on the counter/timer that the frequency selected is within ±0.01 Hz.

AF generator d.c. offset, residual noise, and spurious signals

57. This section checks that the instrument performs to the following specification:-

Spurious less than -26dBc (at 9370 Hz ±20 Hz only). Residual noise less than 0.2 mV r.m.s. in psophometric band (less than 0.4 mV at exactly 1 kHz). DC offset less than 100 mV d.c.

DC offset, residual noise and spurious signals test gear

58. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
DVM	DC measurement down to 1 mV.	Marconi 2610
Audio analyzer	SINAD measurement, psophometric filter.	HP 8903A

Checking d.c. offset

59. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 15.

(2) Set the u.u.t. to AF GEN, frequency 50 Hz, level 0 mV.

(3) Set the d.v.m. to measure d.c. level.

(4) Check that the d.c. level indicated on the d.v.m. is less than 100 mV d.c.

(5) Repeat the above for random frequencies between 50 Hz and 15 kHz.

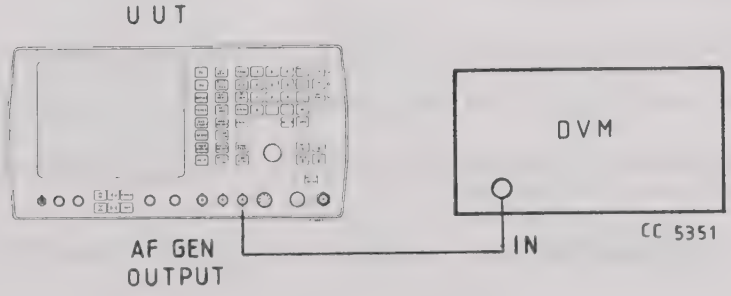

Fig. 15 Test equipment connections for a.f. generator d.c. offset performance checks

Checking residual noise

60. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 16.

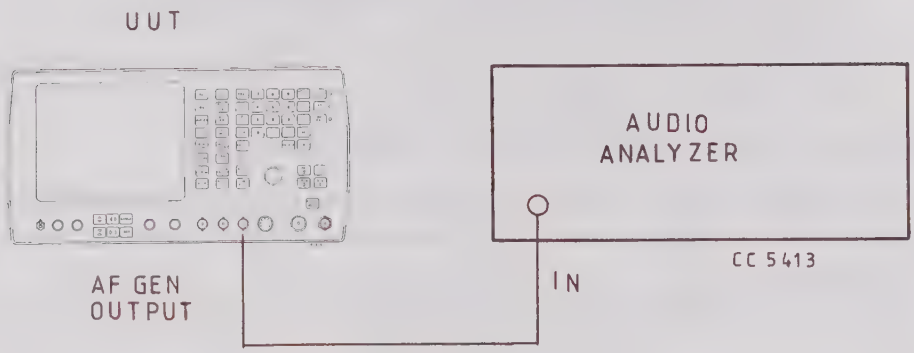

Fig 16 Test equipment connections for a.f. generator residual noise spurious signals performance checks

(2) Set the u.u.t. to AF GEN, frequency 50 Hz, level 0 mV.

(3) Set the audio analyser to a.c. level, psophometric band-pass filter on. All other filters off.

(4) Check that the a.c. level indicated on the audio analyser is less than 0.2 mV r.m.s.

(5) Repeat the above for random frequencies between 50 Hz and 15 kHz.

(6) Repeat for exactly 1 kHz and check that residual noise is less than 0.4 mV r.m.s.

Checking spurious signals

61. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 16.

(2) Set the u.u.t. to AF GEN, frequency 9370 Hz, level 2 V.

(3) Set the audio analyser to 9370 Hz, SINAD, 30 kHz low-pass filter. All other filters off.

(4) Check that the audio analyser reads greater than 27 dB.

DISTORTION/SINAD METER PERFORMANCE CHECKS

62. The distortion/SINAD meter performance check comprises distortion accuracy.

Distortion accuracy specification

63. This section checks that the instrument performs to the following specification:-

Distortion: ±5% of reading ±0.5% distortion. SINAD: ±1 dB.

Distortion accuracy test gear

64. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
LF synthesizer	3.5 kHz sinewave, level 0-1 V r.m.s.	HP 3325A
Distortion meter	0.2% distortion at 1 kHz.	Marconi 2331A
Power splitter	6 dB, d.c. to 50 kHz.	HP 11667A

Checking distortion accuracy

65. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 17.

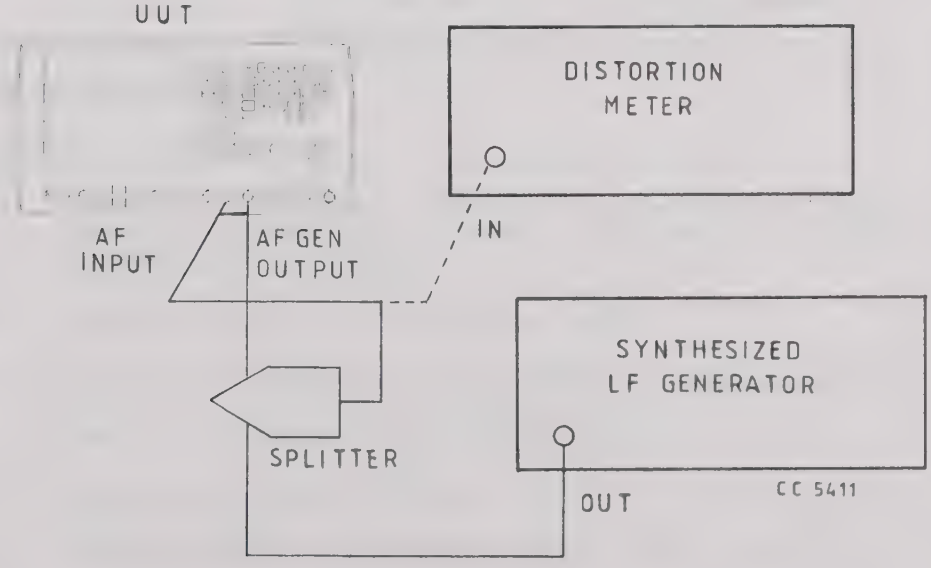

Fig. 17 Test equipment connections for distortion/SINAD meter distortion accuracy performance checks

(2) Set the u.u.t. to RX, distortion on, 50 kHz LOW PASS filter.

(3) Set the synthesized l.f. generator to give a 3.5 kHz sinewave.

(4) Adjust the synthesizer output level until the distortion meter on the u.u.t. indicates 20% distortion.

(5) Remove the splitter from the u.u.t. AF INPUT socket, and connect it to the distortion meter input.

(6) Tune the distortion meter to 1 kHz and check that the distortion displayed is between 18.5 and 21.5%.

(7) Reconnect the splitter to the u.u.t. AF INPUT socket.

(8) Adjust the synthesizer output level until the distortion meter on the u.u.t. indicates 10% distortion.

(9) Select SINAD and the 50 kHz LOW PASS filter on the u.u.t.

(10) Check that the SINAD reading on the u.u.t. is 20 dB ±1 dB.

RF POWER METER PERFORMANCE CHECKS

66. The r.f. power meter performance check comprises accuracy.

Accuracy specification

67. This section checks that the instrument performs to the following specification:-

Accuracy:	±10% ±1 count up to	500 MHz
	±15% ±1 count up to	960 MHz
	±20% ±1 count up to	1000 MHz

Measurement accuracy test gear

68. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Calibrated power source (as below)	Overall uncertainty of 2% up to 500 MHz 3% up to 1000 MHz.	
Signal generator	1.5-1000 MHz, r.f. level 13 dBm.	Marconi 2019A
RF amplifier	1.5-1000 MHz.	Marconi TF2177
Directional coupler	1.5-1000 MHz, 20 dB coupling.	HP 778D (100-1000 MHz) + Mini Circuits ZFDC203 (1.5-100 MHz)
Power meter & Sensor	1.5-1000 MHz, ±0.15 dB accuracy, -30 dBm to +20 dBm.	Marconi 6960, 69012, 6920, sensors

Checking measurement accuracy

69. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 18, using the high frequency coupler. But note that the power source must be calibrated at the frequencies to be checked.

(2) Set the u.u.t. to TX, N-type input socket.

(3) Set the power source to give an output of 2 W at 100 MHz.

(4) Check that the u.u.t. indicates 2 W ±10% ±1 count.

(5) Set the power source to give 220 mW.

(6) Check that the u.u.t. indicates 220 mW ±10% ±1 count.

(7) Repeat the above for random frequencies between 100 and 500 MHz.

(8) Repeat for random frequencies between 500 and 960 MHz and check that the u.u.t. indicates the power sent ±15% ±1 count.

(9) Repeat for random frequencies between 960 and 1000 MHz and check that the u.u.t. indicates the power sent ±20% ±1 count.

(10) Replace the high frequency directional coupler (HP 778D) with the low frequency coupler.

(11) Repeat the above checks for random frequencies between 1.5 and 100 MHz and check that the u.u.t. indicates the power sent ±10% ±1 count.

(12) Set the u.u.t. to one port duplex mode and repeat the above checks.

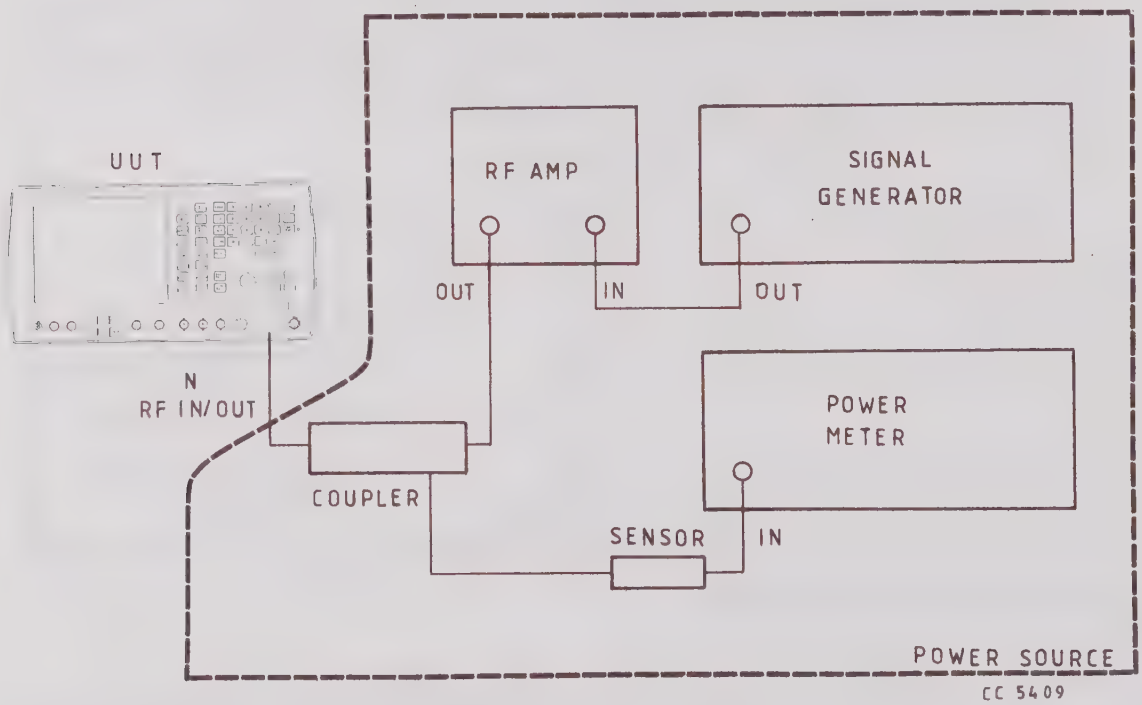

Fig. 18 Test equipment connections for r.f. power meter measurement accuracy performance checks

SELCALL PERFORMANCE CHECKS

70. The Selcall performance checks comprise tones operation.

Tones operation test gear

71. The only test gear required is a second fully operational 2955.

Checking Selcall tones

72. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 19.

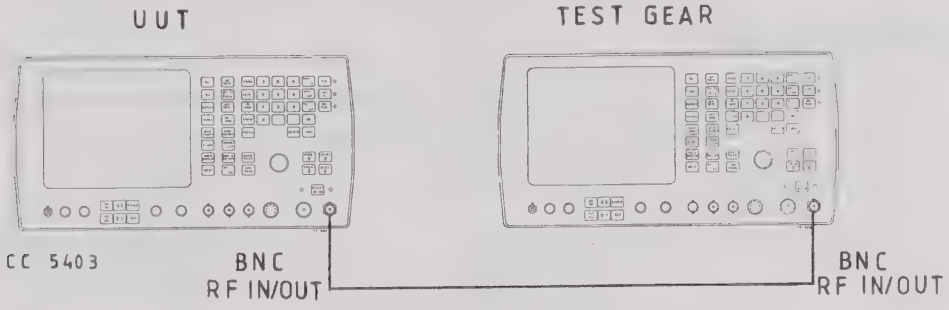

Fig. 19 Test equipment connections for Selcall tones performance checks

(2) Set the u.u.t. to RX, carrier frequency 100 MHz, level 0 dBm, modulation off, b.n.c. output socket.

(3) On the u.u.t. press TONES and select CCIR.

(4) Set the 2955 test gear to TX, b.n.c. input socket. Press TONES and select CCIR.

(5) On the u.u.t. enter tone numbers 1 to 10 using the data keys. Press the tone burst key.

(6) Check that the transmitted tones 1 to 10 appear on the 2955 test gear with 0% error.

(7) Repeat the above with the instrument settings reversed, and check that the u.u.t. receives the tones correctly.

RF GENERATOR PERFORMANCE CHECKS

73. The r.f. generator performance checks comprise: output level, r.f. accuracy, a.m. & f.m. internal accuracy, a.m. & f.m. distortion, external a.m. & f.m., r.f. leakage, f.m. on c.w., and carrier harmonics, sub-harmonics and spurious signals.

Output specification

74. This section checks that the instrument performs to the following specification:-

±2 dB for levels above -127 dBm

Output level test gear

75. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Power meter & sensors	0.4-1000 MHz, -65 to 0dBm, accuracy better than ±0.15 dB.	Marconi 6960 + Sensors 6920 & 6912

Checking output level

76. Proceed as follows, but note that checking low levels (less than -60 dBm) requires the use of specialised attenuator measurement equipment:-

(1) Connect the equipment as shown in Fig. 20, using the 6920 power sensor.

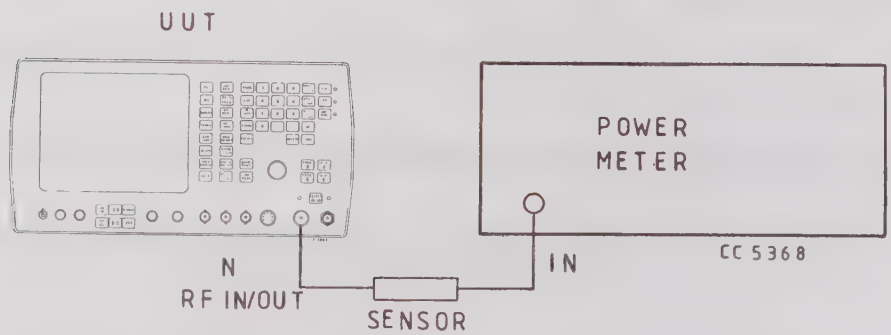

Fig. 20 Test equipment connections for r.f. generator output level performance checks

(2) Set the u.u.t. to RX, RF GEN, carrier frequency 300 MHz, level -20 dBm, increments 1 dB, modulation off, N-type output socket.

(3) Check that the level indicated on the power meter agrees with the level set on the u.u.t. ±2 dB.

(4) Decrement the u.u.t. in 1 dB steps to -60 dBm and check that each step is within +/- 2 dB of the level set.

(5) Repeat the above checks for random frequencies between 10 MHz and 1000 MHz.

(6) Replace the power sensor with the 6912.

(7) Repeat the above checks for random frequencies between 0.4 and 10 MHz.

RF accuracy specification

77. This section checks that the instrument performs to the following specification:-

Accuracy: As internal standard

RF accuracy test gear

78. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Frequency counter	0.4-1000 MHz, 1 MHz standard output	Marconi 2435

Checking r.f. accuracy

79. Note that the following method checks that the frequency synthesizer is working correctly. However, overall accuracy depends upon the correct setting of the internal 10 MHz standard (see under 'Adjustments' in the board checks for AC1). Proceed as follows:-

(1) Connect the equipment as shown in Fig. 21.

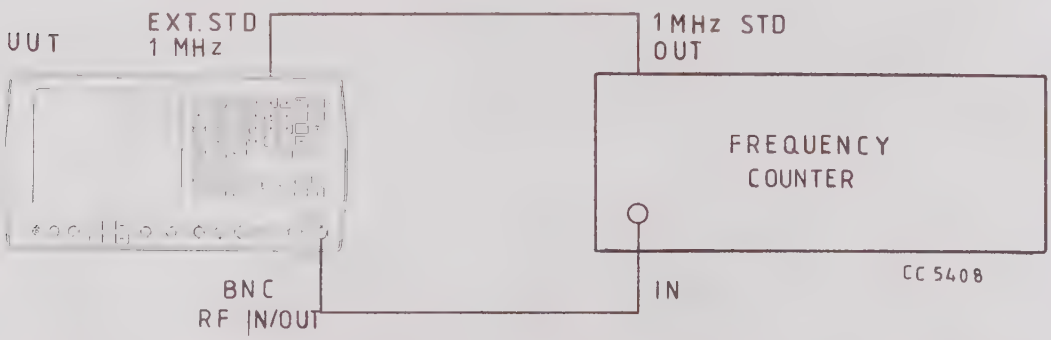

Fig. 21 Test equipment connections for r.f. generator r.f. accuracy performance checks

(2) Set the u.u.t. to RX, RF GEN, carrier frequency 1000 MHz, level 0 dBm, modulation off, b.n.c. output socket.

(3) Check that the counter displays the frequency set on the u.u.t. ±20 Hz.

(4) Repeat the above for random frequencies between 0.4 and 1000 MHz.

AM internal accuracy specification

80. This section checks that the instrument performs to the following specification:-

±7% ±1 digit at 1 kHz. ±10% of reading ±1 digit from 50 Hz to 5 kHz only and 0 to 60% a.m. only. ±15% of reading ±1 digit from 50 Hz to 15 kHz and 0 to 70% a.m.

AM internal accuracy test gear

81. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Modulation meter	AM measurement 0.5-1000 MHz, accuracy 1% at 1 kHz rate, 2.5% at rates 50Hz-15 kHz.	Marconi 2305

Checking internal a.m. accuracy

82. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 22.

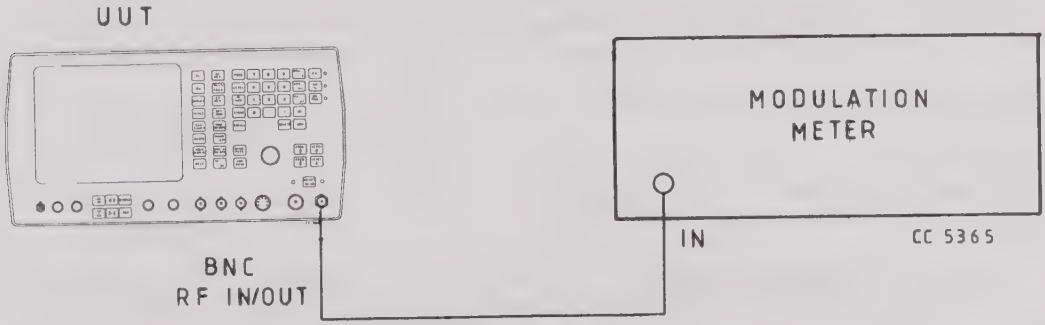

Fig. 22 Test equipment connections for r.f. generator a.m. & f.m. internal accuracy performance checks

(2) Set the u.u.t. to RX, RF GEN, carrier frequency 100 MHz, level 0 dBm, amplitude modulation frequency 1 kHz, modulation level 70%, distortion/SINAD/SN off, b.n.c. output socket.

(3) Set the modulation meter to monitor a.m. with 0.3-3.4 kHz band-pass filter selected.

(4) Check that the a.m. indicated on the modulation meter is within ±7% ±1 digit.

(5) Repeat the above at random levels of modulation between 0 and 70%, at random carrier frequencies between 1.5 and 400 MHz, and at random r.f. levels.

(6) Repeat with random modulation frequencies between 50 Hz and 5 kHz and modulation levels between 0 and 60%, while checking that the modulation meter reading is within ±10% of reading ±1 digit. Ensure that the correct filters are selected on the modulation meter according to the modulation rate being used.

(7) Repeat with random modulation frequencies between 50 kHz and 15 kHz and modulation levels between 0 and 70%, while checking that the modulation meter reading is within ±15% of reading ±1 digit. Ensure that the correct filters are selected on the modulation meter according to the modulation rate being used.

FM internal accuracy specification

83. This section checks that the instrument performs to the following specification:-

±7% ±10 Hz (at 1 kHz) ±10% (50 Hz to 15 kHz)

FM internal accuracy test gear

84. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Modulation meter f.m.	0.5-1000 MHz, accuracy 2%.	Marconi 2305

Checking f.m. internal accuracy

85. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 22.

(2) Set the u.u.t. to RX, RF GEN, carrier frequency 100 MHz, level 0 dBm, f.m. frequency 1 kHz, modulation level 25 kHz, distortion/SINAD/SN off, b.n.c. output socket.

(3) Set the modulation meter to monitor f.m. with 0.3-3.4 kHz band-pass filter selected.

(4) Check that the f.m. deviation indicated on the modulation meter is within ±7% ±10 Hz.

(5) Repeat the above at random deviations between 0 and 25 kHz, and random carrier frequencies between 0.5 and 1000 MHz.

(6) Repeat for modulation rates between 50 Hz and 15 kHz and check that the modulation meter deviation reading is within ±10%. Ensure that the correct filters are selected on the modulation meter according to the modulation rate being used.

AM and f.m distortion specification

86. This section checks that the instrument performs to the following specification:-

AM: <2% distortion at 1 kHz with 30% a.m. in a 0.3-3.4 kHz bandwidth.
FM: <1% distortion at 1 kHz with 5 kHz deviation in a 0.3-3.4 kHz bandwidth.

AM and f.m. distortion test gear

87. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Modulation meter	AM & f.m. modulation, demodulated output.	Marconi 2305*
Distortion meter	Accuracy better than 0.3% at 1 kHz.	Marconi 2331A

* If the modulation meter has the distortion option fitted, the distortion meter is not required.

Checking a.m. & f.m. distortion

88. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 23.

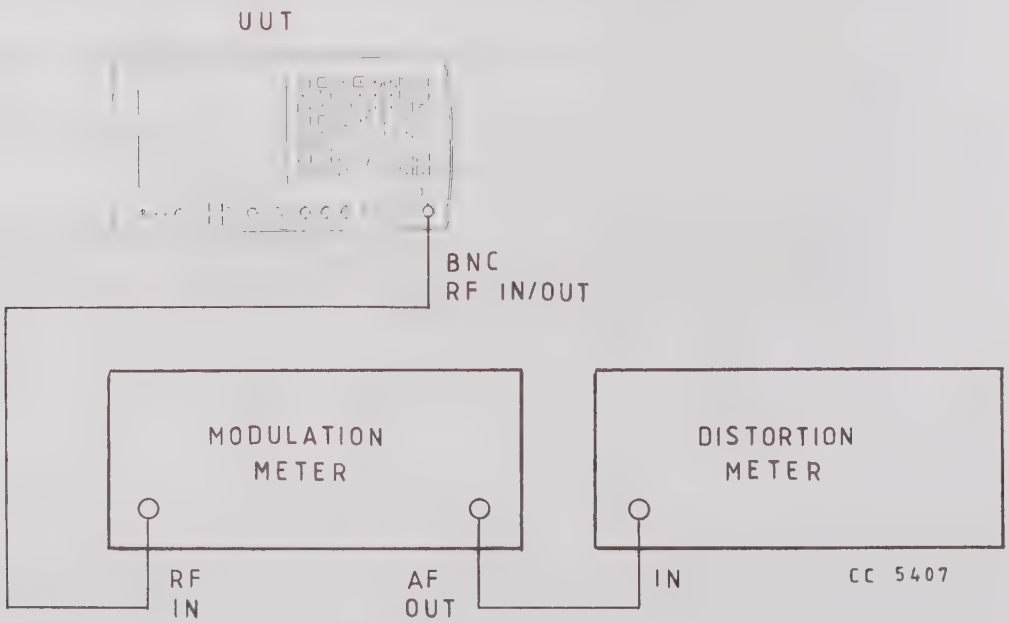

Fig. 23 Test equipment connections for r.f. generator a.m. & f.m. distortion performance checks

(2) Set the u.u.t. to RX, RF GEN, carrier frequency 100 MHz, level 0 dBm, a.m. frequency 1 kHz, modulation depth 30%, distortion/SINAD/SN off, b.n.c. output socket.

(3) Set the modulation meter to monitor a.m. with 0.3-3.4 kHz band-width filter selected.

(4) Tune in the distortion meter and check that the reading is less than 2%.

(5) Change the u.u.t. modulation to 1 kHz f.m. with deviation 5 kHz.

(6) Set the modulation meter to monitor f.m. with 0.3-3.4 kHz band-width filter selected.

(7) Tune in the distortion meter and check that the reading is less than 1%.

External a.m. & f.m. specification

89. This section checks that the instrument performs to the following specification:-

AM sensitivity:	2 V p-p for 40% a.m., ±10% of reading ±1% a.m.
FM sensitivity:	2 V p-p for 10 kHz deviation, ±10% of reading.

External a.m. & f.m. test gear

90. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Modulation meter	1% a.m. accuracy at 1 kHz, 2.5% at rate 50 Hz-15 kHz, f.m. accuracy 2%.	Marconi 2305
LF synthesizer	50 Hz-15 kHz range	HP 3325A
DVM	0.5% accuracy	Datron 1065A

Checking external a.m. & f.m.

91. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 24.

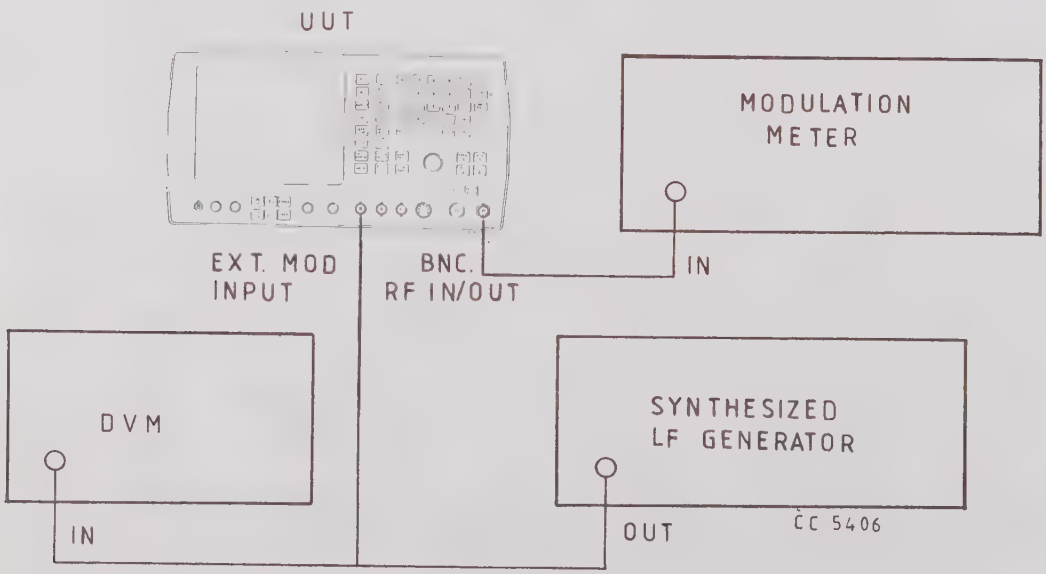

Fig. 24 Test equipment connections for r.f. generator external a.m. & f.m. performance checks

(2) Set the u.u.t. to RX, RF GEN, carrier frequency 100 MHz, level 0.0 dBm, a.m. frequency 1 kHz, modulation depth 0%, distortion/SINAD/SN off, b.n.c. output socket.

(3) Set the synthesized l.f. generator to give a 1 kHz sinewave output and adjust the level to give an r.m.s. reading on the d.v.m. of 0.707.

(4) Set the modulation meter to monitor a.m. and select the 0.3-3.4 kHz band-pass filter.

(5) Check that the modulation meter displays 40% modulation +/- 10% of reading +/- 1% a.m.

(6) Set the u.u.t. to f.m. modulation level 0 kHz.

(7) Set the modulation meter to monitor f.m. with the 0.3-3.4 kHz band-pass filter selected.

(8) Check that the modulation meter displays 10 kHz deviation ±10% of reading.

(9) Repeat the above checks for external modulation frequencies between 50 Hz and 15 kHz. Ensure that the correct filters are selected on the modulation meter according to the modulation rate being used.

RF leakage specification

92. This section checks that the instrument performs to the following specification:-

<0.5 µV p.d. generated in a 50 Ω load by a 2-turn 25 mm loop as near as 25 mm to the case of the instrument with the output set to less than -20 dBm and the output terminated in a 50 Ω sealed load.

RF leakage test gear

93. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Spectrum analyser	0.4-1000 MHz	Marconi TF 2370 + TF 2373.
50 Ω sealed load	—	—
2-turn 25 mm loop	—	—

Checking r.f. leakage

94. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 25, with the 50 Ω load connected to the b.n.c. output socket.

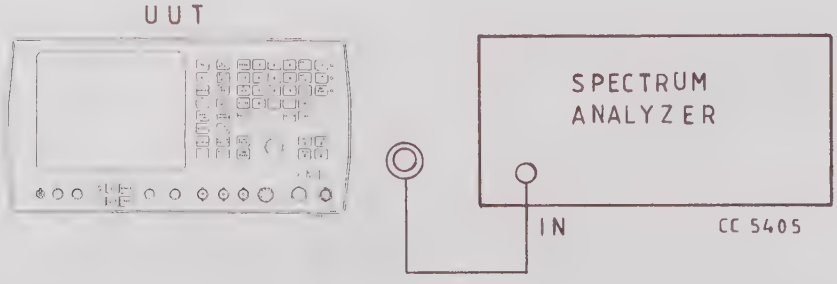

Fig. 25 Test equipment connections for r.f. generator r.f. leakage performance checks

(2) Set the u.u.t. to RX, RF GEN, carrier frequency 500 MHz, level -20 dBm, b.n.c. output socket.

(3) Set the spectrum analyzer to monitor 500 MHz.

(4) Hold the loop 25 mm away from the u.u.t. case and check that the level picked up on the spectrum analyzer is less than 0.5 µV p.d.

FM on c.w. specification

95. This section checks that the instrument performs to the following specification:-

<30 Hz up to 520 MHz (0.3 - 3.4 kHz weighted r.m.s.). <60 Hz up to 1000 MHz (0.3 - 3.4 kHz weighted r.m.s.).

FM on c.w. test gear

96. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Modulation meter	FM noise average, 0-1000 MHz, 0.3-3.4 kHz weighted filter.	Marconi 2305

Checking f.m. on c.w.

97. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 26.

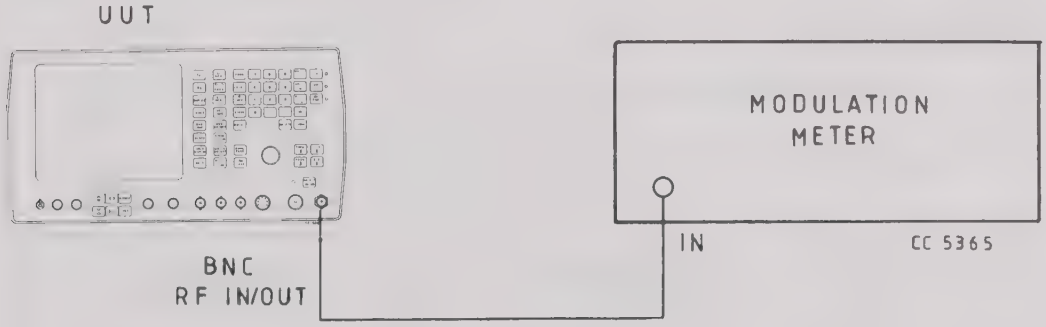

Fig. 26 Test equipment connections for r.f. generator f.m. on c.w. performance checks

(2) Set the u.u.t. to RX, RF GEN, carrier frequency 520 MHz, level 0 dBm, modulation off, b.n.c. output socket.

(3) Set the modulation meter to monitor f.m., with noise average and 0.3-3.4 kHz band-pass filter selected.

(4) Check that the modulation meter indicates less than 30 Hz.

(5) Repeat the above for random frequencies below 520 MHz.

(6) Change the u.u.t. frequency to 1000 MHz and check that the modulation meter reads less than 60 Hz.

(7) Repeat the above for random frequencies between 520 and 1000 MHz.

Carrier harmonics, sub-harmonics & spurious signals specification

98. This section checks that the instrument performs to the following specification:-

Harmonics:	Harmonics are in band 0.4-1000 MHz only. Less than -20 dBc up to 1.5 MHz. Less than -25 dBc 1.5-250 MHz. Less than -20 dBc 250-1000 MHz.
Sub-harmonics:	None up to 530 MHz. Less than -25 dBc to 1000 MHz.
Spurious signals:	Carrier up to 88 MHz. Less than -45 dBc below 110 MHz Less than -35 dBc above 110 MHz. Carrier up to 1000 MHz. Less than -60 dBc.

Harmonics, sub-harmonics & spurious signals test gear

99. The following test gear is required to check the above specification:-

Description	Minimum spec.	Example
Spectrum analyzer	0.4-1000 MHz.	Marconi 2370 + 2373

Checking harmonics

100. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 27.

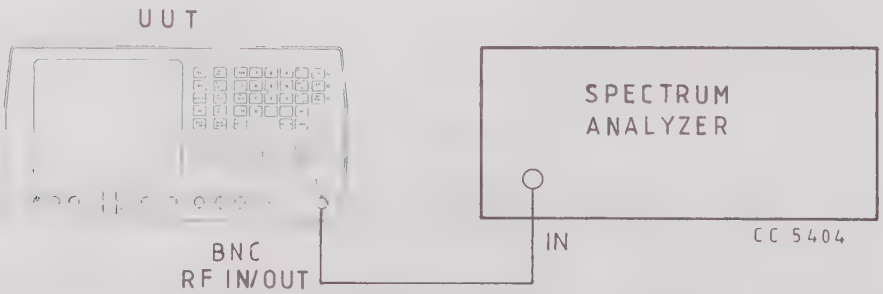

Fig. 27 Test equipment connections for r.f. generator harmonics, sub-harmonics & spurious signals performance checks

(2) Set the u.u.t. to RX, RF GEN, carrier frequency 1.5 MHz, level 0 dBm, b.n.c. output socket.

(3) Adjust the spectrum analyzer controls to reference the 1.5 MHz fundamental on the top graticule line.

(4) Check that the harmonics are less than -20 dBc.

(5) Repeat the above at random frequencies between 0.4 and 1.5 MHz.

(6) Repeat at random frequencies between 1.5 and 250 MHz, checking that the harmonics are less than -25 dBc.

(7) Repeat at random frequencies between 250 and 1000 MHz, checking that the harmonics are less than -20 dBc.

Checking sub-harmonics

101. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 27.

(2) Set the u.u.t. to RX, RF GEN, carrier frequency 530 MHz, level 0 dBm, b.n.c. output socket.

(3) Adjust the spectrum analyzer to reference the 530 MHz fundamental on the top graticule line.

(4) Check that all sub-harmonics are less than -25 dBc.

(5) Repeat the above for r.f. generator frequncies between 530 and 1000 MHz.

Checking spurious signals

102. Proceed as follows:-

(1) Connect the equipment as shown in Fig. 27.

(2) Set the u.u.t. to RX, RF GEN, carrier frequency 88 MHz, level 0.0 dBm, b.n.c. output socket.

(3) Adjust the spectrum analyzer controls to reference the 88 MHz fundamental on the top graticule line.

(4) Check that all spurious signals below 110 MHz are less than -45 dBc and all spurious signals above 110 MHz are less than -35 dBc.

(5) Repeat for random carrier frequencies between 0.4 and 88 MHz.

(6) Repeat for random carrier frequencies between 88 and 1000 MHz checking that all spurious signals are less than -60 dBc.

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MP MASTER

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